

Appendix I

Toxicity Reference Values for Each Contaminant/Functional Group

Table I-1. Compilation of toxicity reference values (TRVs in mg/kg-day) for mammalian functional groups.

Chemical	TRV for M121	TRV for M122	TRV for M122A	TRV for M123	TRV for M210	TRV for M210A	TRV for M222	TRV for M322	TRV for M422	TRV for M422A
2-Methylnaphthalene (Mouse - Cancer) ^a	*	*	*	*	*	*	*	*	*	*
2-Methylnaphthalene (Rat - Cancer) ^a	*	*	*	*	*	*	*	*	*	*
Acetone (Mouse and Rat -- NOAEL)	8.3	8.3	8.3	8.3	8.3	8.3	8.3	8.3	13	13
Antimony (Mouse - NOAEL)	0.23	0.23	0.23	0.23	0.23	0.23	0.23	0.23	0.35	0.35
Arsenic (Dog - NOAEL)	0.11	0.11	0.11	0.11	0.11	0.11	0.11	0.11	0.16	0.32
Arsenic (Mouse - LOAEL)	0.052	0.052	0.052	0.052	0.052	0.052	0.052	0.052	0.08	0.08
Arsenic (Rat - NOAEL)	0.26	0.26	0.26	0.26	0.26	0.26	0.26	0.26	0.39	0.39
Arsenic (Sheep - NOAEL)	0.06	0.06	0.06	0.06	0.04	0.04	0.04	0.04	0.04	0.04
Barium (Rat - NEL)	47.5	47.5	47.5	47.5	47.5	47.5	47.5	47.5	71.2	71.2
Barium (Dog - FEL-1)	0.24	0.24	0.24	0.24	0.24	0.24	0.24	0.24	0.36	0.73
Barium Chloride (Rat - NOAEL)	5.81	5.81	5.81	5.81	5.81	5.81	5.81	5.81	8.71	8.71
Benzene (Mouse - LOAEL)	3.66	3.66	3.66	3.66	3.66	3.66	3.66	3.66	5.49	5.49
Benzene (Mouse and Rat - FEL)	0.69	0.69	0.69	0.69	0.69	0.69	0.69	0.69	1.0	1.0
Benzo(a)anthracene (Mouse - FEL)	9.3	9.3	9.3	9.3	9.3	9.3	9.3	9.3	14	14
Benzo(a)pyrene (Mouse - FEL)	92.6	92.6	92.6	92.6	92.6	92.6	92.6	92.6	139	139
Benzo(a)pyrene (Mouse - Cancer)	0.02	0.02	0.02	0.02	0.02	0.02	0.02	0.02	0.03	0.03
Benzo(b)fluoranthene (BbF) (Mouse - LOAEL)	0.02	0.02	0.02	0.02	0.02	0.02	0.02	0.02	0.03	0.03
Benzo(ghi)perylene ^a	*	*	*	*	*	*	*	*	*	*
Benzo(k)fluoranthene ^a	*	*	*	*	*	*	*	*	*	*
Cadmium (Rat - LOAEL)	8E-4	8E-4	8E-4	8E-4	8E-4	8E-4	8E-4	8E-4	1E-3	1E-3
Chromium (III) (Rat - NOAEL)	250	250	250	250	250	250	250	250	375	375
Chrysene ^b (Mouse - LOAEL)	b	b	b	b	b	b	b	b	b	b
Cobalt (Dog - NOAEL)	1.4	1.4	1.4	1.4	1.4	1.4	1.4	1.4	2.1	2.1

Table I-1. (continued).

Chemical	TRV for M121	TRV for M122	TRV for M122A	TRV for M123	TRV for M210	TRV for M210A	TRV for M222	TRV for M322	TRV for M422	TRV for M422A
Cobalt (Rat - NOAEL)	0.14	0.14	0.14	0.14	0.14	0.14	0.14	0.14	0.21	0.21
Copper (Mink - NOAEL)	0.437	0.437	0.437	0.437	0.437	0.437	0.437	1.31	0.437	0.437
Copper (Rat - NOAEL)	1.8	1.8	1.8	1.8	1.8	1.8	1.8	1.8	2.8	2.8
Dibenzo(a,h)anthracene ^a	a	a	a	a	a	a	a	a	a	a
Indeno(1,2,3-cd)pyrene ^a	a	a	a	a	a	a	a	a	a	a
Lead (Bovine - LD ₅₀)	0.038	0.038	0.038	0.038	0.025	0.025	0.025	0.025	0.025	0.025
Lead (Dog - NOAEL)	0.81	0.81	0.81	0.81	0.81	0.81	0.81	0.81	1.6	3.3
Lead (Dog - FEL)	0.006	0.006	0.006	0.006	0.006	0.006	0.006	0.006	0.009	0.018
Lead (Rat - NOAEL)	0.12	0.12	0.12	0.12	0.12	0.12	0.12	0.12	0.18	0.18
Lead (Rat - NOAEL)	2.7	2.7	2.7	2.7	2.7	2.7	2.7	2.7	4.0	4.0
Manganese (Rat - NOAEL)	29	29	29	29	29	29	29	29	44	44
Mercury (Inorganic) (Mouse - NOAEL)	0.11	0.11	0.11	0.11	0.11	0.11	0.11	0.11	0.17	0.17
Mercury (Inorganic) (Swine - NOAEL)	0.021	0.021	0.021	0.021	0.021	0.021	0.021	0.021	0.031	0.031
Mercury (Organic) (Bovine - NOAEL)	0.006	0.006	0.006	0.006	0.004	0.004	0.004	0.004	0.004	0.004
Mercury (Organic) (Mink - NOAEL)	0.019	0.019	0.019	0.019	0.013	0.013	0.013	0.013	0.013	0.013
Mercury (Organic) (Mouse - NOAEL)	0.02	0.02	0.02	0.02	0.02	0.02	0.02	0.02	0.04	0.04
Mercury (Organic) (Swine - NOAEL)	0.0021	0.0021	0.0021	0.0021	0.0021	0.0021	0.0021	0.0021	0.0031	0.0031
Mercury (Organic) (Rat - NOAEL)	0.008	0.008	0.008	0.008	0.008	0.008	0.008	0.008	0.013	0.013
Mercury (Organic) (Rat - NOAEL)	0.0083	0.0083	0.0083	0.0083	0.0083	0.0083	0.0083	0.0083	0.013	0.013
Mercury (Organic) (Deer - LD ₅₀)	0.11	0.11	0.11	0.11	0.07	0.07	0.07	0.07	0.07	0.07
Mercury (Organic) (Cat - NOAEL)	0.002	0.002	0.002	0.002	0.002	0.002	0.002	0.005	0.002	0.003

Table I-1. (continued).

Chemical	TRV for M121	TRV for M122	TRV for M122A	TRV for M123	TRV for M210	TRV for M210A	TRV for M222	TRV for M322	TRV for M422	TRV for M422A
Nickel (Bovine - NOAEL)	0.11	0.11	0.11	0.11	0.08	0.08	0.08	0.08	0.08	0.08
Nickel (Dog - NOAEL)	4.2	4.2	4.2	4.2	4.2	4.2	4.2	4.2	6.3	13
Nickel (Rat - NOAEL)	0.83	0.83	0.83	0.83	0.83	0.83	0.83	0.83	1.3	1.3
Nitrate (Rabbit - AEL)	83.21	83.21	83.21	83.21	55.47	55.47	55.47	55.47	55.47	55.47
PCBs - Aroclor 1254 (Mouse - FEL)	0.025	0.025	0.025	0.025	0.025	0.025	0.025	0.025	0.038	0.038
PCBs - Aroclor 1254 (Mink - NOAEL)	0.046	0.046	0.046	0.046	0.046	0.046	0.046	0.137	0.046	0.046
PCBs - Aroclor 1254 (Rat - NOAEL)	0.11	0.11	0.11	0.11	0.11	0.11	0.11	0.11	0.16	0.16
PCBs - Aroclor 1254 (Mink - NOAEL)	0.005	0.005	0.005	0.005	0.005	0.005	0.005	0.015	0.005	0.005
Pyrene (Mouse - NOAEL)	13	13	13	13	13	13	13	13	19	19
Selenium (Mouse - FEL)	0.04	0.04	0.04	0.04	0.04	0.04	0.04	0.04	0.06	0.06
Selenium (Rat - NOAEL)	0.025	0.025	0.025	0.025	0.025	0.025	0.025	0.025	0.038	0.038
Selenium (Sheep - FEL)	0.02	0.02	0.02	0.02	0.01	0.01	0.01	0.01	0.01	0.01
Silver (Mouse - FEL)	0.8	0.8	0.8	0.8	0.8	0.8	0.8	0.8	1.3	1.3
Sulfate (Rat - LD ₅₀)	5.32	5.32	5.32	5.32	5.32	5.32	5.32	5.32	7.98	7.98
Thallium (Rat - FEL)	0.04	0.04	0.04	0.04	0.04	0.04	0.04	0.04	0.06	0.06
Thallium (Rat - LOAEL)	0.04	0.04	0.04	0.04	0.04	0.04	0.04	0.04	0.06	0.06
Total Petroleum Hydrocarbon ^c	c	c	c	c	c	c	c	c	c	c
Vanadium (Bovine - NOAEL)	0.47	0.47	0.47	0.47	0.31	0.31	0.31	0.31	0.31	0.31
Vanadium (Mouse - NOAEL)	0.46	0.46	0.46	0.46	0.46	0.46	0.46	0.46	0.68	0.68
Xylene (Mouse - NOAEL)	0.086	0.086	0.086	0.086	0.086	0.086	0.086	0.086	0.129	0.129
Xylene (Rat - NOAEL)	20.8	20.8	20.8	20.8	20.8	20.8	20.8	20.8	31.3	31.3
Zinc (Ferret - NOAEL)	3.94	3.94	3.94	3.94	3.94	3.94	3.94	11.8	3.94	5.92
Zinc (Rat - NOAEL)	14	14	14	14	14	14	14	14	21	21

Table I-1. (continued).

Chemical	TRV for M121	TRV for M122	TRV for M122A	TRV for M123	TRV for M210	TRV for M210A	TRV for M222	TRV for M322	TRV for M422	TRV for M422A
a. Values for benzo(a)pyrene used										
b. Dermal exposure										
c. Values for benzene used										
No data located for:										
Chloromethane										
Dibenzofuran										
4-Methyl-2-pentanone										
Pentachlorophenol										

Table I-2. Compilation of toxicity reference values (TRVs in mg/kg-day) for avian functional groups.

Chemical	TRV for AV121	TRV for AV122	TRV for AV132	TRV for AV142	TRV for AV143	TRV for AV210	TRV for AV210A	TRV for AV221	TRV for AV222	TRV for AV222A	TRV for AV232
Arsenic (Brown-headed cowbird -Mortality)	0.046	0.046	0.046	0.046	0.046	0.069	0.069	0.069	0.069	0.069	0.069
Arsenic (Mallard - NOAEL)	0.64	0.64	0.64	1.29	1.29	0.43	0.43	0.43	0.43	0.43	0.43
Arsenic (Mallard - LD ₅₀)	0.24	0.24	0.24	0.48	0.48	0.16	0.16	0.16	0.16	0.16	0.16
Cadmium (Black Duck - LOAEL)	0.04	0.04	0.04	0.07	0.07	0.02	0.02	0.02	0.02	0.02	0.02
Cadmium (Chicken - LOAEL)	0.27	0.27	0.27	0.27	0.27	0.27	0.27	0.27	0.27	0.27	0.27
Chromium-III (Chicken - NOAEL)	1.4	1.4	1.4	1.4	1.4	1.4	1.4	1.4	1.4	1.4	1.4
Cobalt (Chicken - LOAEL)	0.213	0.213	0.213	0.213	0.213	0.213	0.213	0.213	0.213	0.213	0.213
Copper (Chicken - NOAEL)	27.89	27.89	27.89	27.89	27.89	27.89	27.89	27.89	27.89	27.89	27.89
Copper (Chicken - NOAEL)	4.61	4.61	4.61	4.61	4.61	4.61	4.61	4.61	4.61	4.61	4.61
Lead (Chicken - NOAEL)	0.48	0.48	0.48	0.48	0.48	0.48	0.48	0.48	0.48	0.48	0.48
Lead (European Starling - LOAEL)	0.03	0.03	0.03	0.03	0.03	0.04	0.08	0.04	0.04	0.04	0.04
Manganese (Chicken - NOAEL)	70.0	70.0	70.0	70.0	70.0	70.0	70.0	70.0	70.0	70.0	70.0
Manganese (Japanese Quail - NOAEL)	21.3	21.3	21.3	21.3	21.3	21.3	21.3	21.3	21.3	21.3	21.3
Mercury (Inorganic) (Japanese quail - NOAEL)	0.16	0.16	0.16	0.16	0.16	0.16	0.16	0.16	0.16	0.16	0.16
Mercury (Inorganic) (Chicken - NOAEL)	2.02	2.02	2.02	2.02	2.02	2.02	2.02	2.02	2.02	2.02	2.02
Mercury (Organic) (American black duck - AEL)	0.0047	0.0047	0.0047	0.0094	0.0094	0.0031	0.0031	0.0031	0.0031	0.0031	0.0031
Mercury (Organic) (Mallard - LOAEL)	0.012	0.012	0.012	0.024	0.024	0.008	0.008	0.008	0.008	0.008	0.008
Mercury (Organic) (Pheasant - AEL)	0.004	0.004	0.004	0.004	0.004	0.004	0.004	0.004	0.004	0.004	0.004
Mercury (Organic) (Pheasant - LOAEL)	0.005	0.005	0.005	0.005	0.005	0.005	0.005	0.005	0.005	0.005	0.005
Nickel (Chicken - NOAEL)	2.1	2.1	2.1	2.1	2.1	2.1	2.1	2.1	2.1	2.1	2.1
Nickel (Mallard - NOAEL)	8.75	8.75	8.75	17.5	17.5	5.83	5.83	5.83	5.83	5.83	5.83
Nickel (Mallard - NOAEL)	50	50	50	100	100	33	33	33	33	33	33

Table I-2. (continued).

Chemical	TRV for AV121	TRV for AV122	TRV for AV132	TRV for AV142	TRV for AV143	TRV for AV210	TRV for AV210A	TRV for AV221	TRV for AV222	TRV for AV222A	TRV for AV232
Nitrate (Turkey - FEL)	8.9	8.9	8.9	8.9	8.9	8.9	8.9	8.9	8.9	8.9	8.9
PCBs (1254) (Pheasant - LOAEL)	0.08	0.08	0.08	0.08	0.08	0.08	0.08	0.08	0.08	0.08	0.08
Selenium (Black Crowned Night Heron - LOAEL)	0.10	0.10	0.10	0.10	0.10	0.10	0.10	0.10	0.10	0.10	0.10
Selenium (Chicken - NOAEL)	0.033	0.033	0.033	0.033	0.033	0.033	0.033	0.033	0.033	0.033	0.033
Selenium (Mallard - NOAEL)	0.13	0.13	0.13	0.25	0.25	0.08	0.08	0.08	0.08	0.08	0.08
Sulfate (Turkey - NOAEL)	8.64	8.64	8.64	8.64	8.64	8.64	8.64	8.64	8.64	8.64	8.64
Thallium (Quail - FEL)	0.05	0.05	0.05	0.05	0.05	0.05	0.05	0.05	0.05	0.05	0.05
Vanadium (Chicken - NOAEL)	0.14	0.14	0.14	0.14	0.14	0.14	0.14	0.14	0.14	0.14	0.14
Vanadium (Mallard - NOAEL)	0.13	0.13	0.13	0.25	0.25	0.08	0.08	0.08	0.08	0.08	0.08
Zinc (Chicken - LOAEL)	2.0	2.0	2.0	2.0	2.0	2.0	2.0	2.0	2.0	2.0	2.0
Zinc (Mallard - LOAEL)	12.9	12.9	12.9	25.9	25.9	8.63	8.63	8.63	8.63	8.63	8.63

Table I-2. (continued).

Chemical	TRV for AV233	TRV for AV241	TRV for AV242	TRV for AV310	TRV for AV322	TRV for AV333	TRV for AV342	TRV for AV422	TRV for AV432	TRV for AV433	TRV for AV442
Arsenic (Brown-headed cowbird - Mortality)	0.069	0.069	0.069	0.046	0.046	0.046	0.046	0.046	0.046	0.046	0.046
Arsenic (Mallard - NOAEL)	0.43	0.43	0.43	0.43	0.43	0.43	0.43	0.43	0.43	0.43	0.43
Arsenic (Mallard - LD ₅₀)	0.16	0.16	0.16	0.16	0.16	0.16	0.16	0.16	0.16	0.16	0.16
Cadmium (Black Duck - LOAEL)	0.02	0.02	0.02	0.02	0.02	0.02	0.02	0.02	0.02	0.02	0.02
Cadmium (Chicken - LOAEL)	0.18	0.18	0.18	0.18	0.18	0.18	0.18	0.27	0.27	0.27	0.27
Chromium-III (Chicken - NOAEL)	1.4	1.4	1.4	1.4	1.4	1.4	1.4	2.0	2.0	2.0	2.0
Cobalt (Chicken - LOAEL)	0.213	0.213	0.213	0.213	0.213	0.213	0.213	0.319	0.319	0.319	0.319
Copper (Chicken - NOAEL)	27.89	27.89	27.89	27.89	27.89	27.89	27.89	41.92	41.92	41.92	41.92
Copper (Chicken - NOAEL)	4.61	4.61	4.61	4.61	4.61	4.61	4.61	6.91	6.91	6.91	6.91
Lead (Chicken - NOAEL)	0.48	0.48	0.48	0.48	0.48	0.48	0.48	0.72	0.72	0.72	0.72
Lead (European Starling - LOAEL)	0.04	0.04	0.04	0.03	0.03	0.03	0.03	0.03	0.03	0.03	0.03
Manganese (Chicken - NOAEL)	70.0	70.0	70.0	70.0	70.0	70.0	70.0	105	105	105	105
Manganese (Japanese Quail - NOAEL)	21.3	21.3	21.3	21.3	21.3	21.3	21.3	31.9	31.9	31.9	31.9
Mercury (Inorganic) (Japanese quail - NOAEL)	0.16	0.16	0.16	0.16	0.16	0.16	0.16	0.24	0.24	0.24	0.24
Mercury (Inorganic) (Chicken - NOAEL)	2.02	2.02	2.02	2.02	2.02	2.02	2.02	3.03	3.03	3.03	3.03
Mercury (Organic) (American black duck - AEL)	0.0031	0.0031	0.0031	0.0031	0.0031	0.0031	0.0031	0.0031	0.0031	0.0031	0.0031
Mercury (Organic) (Mallard - LOAEL)	0.008	0.008	0.008	0.008	0.008	0.008	0.008	0.008	0.008	0.008	0.008
Mercury (Organic) (Pheasant - AEL)	0.004	0.004	0.004	0.004	0.004	0.004	0.004	0.0059	0.0059	0.0059	0.0059
Mercury (Organic) (Pheasant - LOAEL)	0.005	0.005	0.005	0.005	0.005	0.005	0.005	0.008	0.008	0.008	0.008
Nickel (Chicken - NOAEL)	2.1	2.1	2.1	2.1	2.1	2.1	2.1	3.1	3.1	3.1	3.1

Table I-2. (continued).

Chemical	TRV for AV233	TRV for AV241	TRV for AV242	TRV for AV310	TRV for AV322	TRV for AV333	TRV for AV342	TRV for AV422	TRV for AV432	TRV for AV433	TRV for AV442
Nickel (Mallard - NOAEL)	5.83	5.83	5.83	5.83	5.83	5.83	5.83	5.83	5.83	5.83	5.83
Nickel (Mallard - NOAEL)	33	33	33	33	33	33	33	33	33	33	33
Nitrate (Turkey - FEL)	8.9	8.9	8.9	8.9	8.9	8.9	8.9	13.4	13.4	13.4	13.4
PCBs (1254) (Pheasant - LOAEL)	0.08	0.08	0.08	0.08	0.08	0.08	0.08	0.11	0.11	0.11	0.11
Selenium (Black Crowned Night Heron - LOAEL)	0.10	0.10	0.10	0.16	0.16	0.16	0.16	0.10	0.10	0.10	0.10
Selenium (Chicken - NOAEL)	0.033	0.033	0.033	0.033	0.033	0.033	0.033	0.050	0.050	0.050	0.050
Selenium (Mallard - NOAEL)	0.08	0.08	0.08	0.08	0.08	0.08	0.08	0.08	0.08	0.08	0.08
Sulfate (Turkey - NOAEL)	8.64	8.64	8.64	8.64	8.64	8.64	8.64	12.96	12.96	12.96	12.96
Thallium (Quail - FEL)	0.05	0.05	0.05	0.05	0.05	0.05	0.05	0.07	0.07	0.07	0.07
Vanadium (Chicken - NOAEL)	0.14	0.14	0.14	0.14	0.14	0.14	0.14	0.21	0.21	0.21	0.21
Vanadium (Mallard - NOAEL)	0.08	0.08	0.08	0.08	0.08	0.08	0.08	0.08	0.08	0.08	0.08
Zinc (Chicken - LOAEL)	2.0	2.0	2.0	2.0	2.0	2.0	2.0	3.0	3.0	3.0	3.0
Zinc (Mallard - LOAEL)	8.63	8.63	8.63	8.63	8.63	8.63	8.63	8.63	8.63	8.63	8.63

No data located for:

Acetone

Antimony

Barium

Benzo(a)anthracene

Benzo(a)pyrene

Benzo(b)fluoranthene

Benzo(g,h,i)perylene

Benzo(k)fluoranthene

Chloromethane

Chrysene

Dibenzo(a,h)anthracene

Dibenzofuran

Indeno(1,2,3-cd)pyrene

2-Methylnaphthalene

4-Methyl-2-pentanone

Pentachlorophenol

Pyrene

Silver

TPH

Xylene

COPC: Acetone CAS 67-64-1

Test Organisms: Rat and Mouse (Omnivore, Order-Rodentia)

Exposure Medium: Oral (gavage)

Test Endpoint: NOAEL

Reference: EPA, 1986, *Ninety-Day Gavage Study in Albino Rats Using Acetone*, Office of Solid Waste, Washington, DC.

QCE: 100 mg/kg-day

Adjustment Factors (AF)				Justification for adjustment factor
R	1	2	3	R = 1 is AF for same order and trophic level R = 2 is AF for different order and same trophic level R = 3 is AF for different order and trophic level
I	2	2	2	30 each sex/treatment group evaluated. No juveniles tested.
Q ₁	1	1	1	Ecologically relevant endpoint
Q ₂	1	1	1	Chronic (90-day) study
Q ₃	1	1	1	NOAEL
U	2	2	2	Numerous endpoints measured. Adequate number of animals tested. Supporting chronic toxicity and reproductive studies are lacking.
Total AF	4	8	12	$R * I * Q_1 * Q_2 * Q_3 * U = \text{Total AF}$
QCE (mg/kg-day)	100	100	100	QCE = quantified critical endpoint
TRV	25	13	8.3	Toxicity Reference Value = QCE/Total AF

R Value	TRV (mg/kg-day)	Justification	Appropriate Functional Group
1	25	Test organism is in the same order and trophic level as the functional group members	none
2	13	Test organism is in a different order and same trophic level from the functional group members	M422, M422A
3	8.3	Test organism is in a different order and trophic level from the functional group members	M122, M122A, M121, M123, M132 M210, M210A, M222, M322

COPC: Antimony (Antimony Potassium Tartrate) CAS 7440-36-0

Test Organisms: Mouse (Omnivore, Order-Rodentia)

Exposure Medium: Water

Test Endpoint: NOAEL Apparent slight decrease in life span of female CD-1 mice (significance unknown)

Reference: Schroeder, H.A., M. Mitchner, and J.J. Balassa, 1968, *Zirconium, Niobium, Antimony and Fluorine in Mice: Effects of Growth Survival and Tissue Levels*, Journal of Nutrition, 95:95-101.
Kanisawa, M. and H.A. Schroeder, 1969, "Life term studies on the effect of trace elements on spontaneous tumor in mice and rats." Cancer Research, 29(4):892-895.

QCE: 0.35 mg/kg-day 5mg/L*7.0mL/100g-day*L/1000mL*1000g/1kg

Adjustment Factors (AF)				Justification for adjustment factor
R	1	2	3	R = 1 is AF for same order and trophic level R = 2 is AF for different order and same trophic level R = 3 is AF for different order and trophic level
I	1	1	1	Chronic toxicity studies with adequate numbers of animals.
Q ₁	0.5	0.5	0.5	Endpoint could occur, but of uncertain ecological significance
Q ₂	1	1	1	Chronic study
Q ₃	1	1	1	NOAEL endpoint
U	2	2	2	Large chronic study, but no reproductive endpoints examined.
M	0.5	0.5	0.5	Soluble salts in the drinking water were used
Total AF	0.5	1.0	1.5	$R * I * Q_1 * Q_2 * Q_3 * U * M = \text{Total AF}$
QCE (mg/kg-day)	0.35	0.35	0.35	QCE = quantified critical endpoint
TRV	0.70	0.35	0.23	Toxicity Reference Value = QCE/Total AF

R Value	TRV (mg/kg-day)	Justification	Appropriate Functional Group
1	0.70	Test organism is in the same order and trophic level as the functional group members	none
2	0.35	Test organism is in a different order and same trophic level from the functional group members	M422, M422A
3	0.23	Test organism is in a different order and trophic level from the functional group members	M122, M122A, M121, M123, M132 M210, M210A, M222, M322

COPC: Arsenic CAS 7440-38-2

Test Organisms: Brown-headed cowbird (Insectivore, Order-Passeriformes)

Exposure Medium: NA

Test Endpoint: Mortality

Reference: US Fish and Wildlife Service, 1969, Bureau of Sport Fisheries and Wildlife, Publication 74, pp 56-57.

QCE: 2.46 mg/kg-day

Adjustment Factors (AF)				Justification for adjustment factor
R	1	2	3	R = 1 is AF for same order and trophic level R = 2 is AF for different order and same trophic level R = 3 is AF for different order and trophic level
I	2	2	2	Males only.
Q ₁	1	1	1	Mortality
Q ₂	1	1	1	Chronic (7 months)
Q ₃	3	3	3	Mortality
U	3	3	3	Four dose levels- both a LOAEL and NOAEL established
Total AF	18	36	54	$R * I * Q_1 * Q_2 * Q_3 * U = \text{Total AF}$
QCE (mg/kg-day)	2.46	2.46	2.46	QCE = quantified critical endpoint
TRV	0.137	0.069	0.046	Toxicity Reference Value = QCE/Total AF

R Value	TRV (mg/kg-day)	Justification	Appropriate Functional Group
1	0.137	Test organism is in the same order and trophic level as the functional group members	none
2	0.069	Test organism is in a different order and same trophic level from the functional group members	AV210, AV210A, AV221, AV222, AV222A, AV232, AV233, AV241, AV242
3	0.046	Test organism is in a different order and trophic level from the functional group members	AV121, AV122, AV132, AV142, AV143, AV310, AV322, AV333, AV342, AV422, AV432, AV433, AV442

COPC: Arsenic CAS 7440-38-2

Test Organisms: Mallard (Herbivore, Order-Anseriformes)

Exposure Medium: NA

Test Endpoint: LD₅₀

Reference: National Academy of Sciences (NAS), 1977, *Arsenic*, Washington DC.

QCE: 39 mg/kg-day

Adjustment Factors (AF)				Justification for adjustment factor
R	1	2	3	R = 1 is AF for same order and trophic level R = 2 is AF for different order and same trophic level R = 3 is AF for different order and trophic level
I	3	3	3	Secondary source with little supporting variation data.
Q ₁	1	1	1	Relevant effect (mortality).
Q ₂	3	3	3	Study duration was acute
Q ₃	3	3	3	LD ₅₀
U	3	3	3	Old study, secondary source (supporting info only)
Total AF	81	162	243	$R * I * Q_1 * Q_2 * Q_3 * U = \text{Total AF}$
QCE (mg/kg-day)	39	39	39	QCE = quantified critical endpoint
TRV	0.48	0.24	0.16	Toxicity Reference Value = QCE/Total AF

R Value	TRV (mg/kg-day)	Justification	Appropriate Functional Group
1	0.48	Test organism is in the same order and trophic level as the functional group members	AV142, AV143
2	0.24	Test organism is in a different order and same trophic level from the functional group members	AV121, AV122, AV132
3	0.16	Test organism is in a different order and trophic level from the functional group members	AV210, AV210A, AV221, AV222, AV222A, AV232, AV233, AV241, AV242, AV310, AV322, AV333, AV342, AV422, AV432, AV433, AV442

COPC: Arsenic CAS 7740-38-2

Test Organisms: Domestic sheep (Herbivore, Order-Artiodactyla)

Exposure Medium: Diet

Test Endpoint: NOAEL

Reference: Eisler, R. 1988, *Arsenic Hazards to Fish, Wildlife, and Invertebrates: A Synoptic Review*, US Fish and Wildlife Service Biological Report, 85(1.12):92pp.

QCE: 2.3 mg/kg-day

Adjustment Factors (AF)				Justification for adjustment factor
R	1	2	3	R = 1 is AF for same order and trophic level R = 2 is AF for different order and same trophic level R = 3 is AF for different order and trophic level
I	3	3	3	Secondary source with no data regarding variability of response.
Q ₁	1	1	1	Relevant effect.
Q ₂	2	2	2	Subacute duration.
Q ₃	1	1	1	NOEL endpoint.
U	3	3	3	Secondary source, only one dose level.
Total AF	18	36	54	$R * I * Q_1 * Q_2 * Q_3 * U = \text{Total AF}$
QCE (mg/kg-day)	2.3	2.3	2.3	QCE = quantified critical endpoint
TRV	0.13	0.06	0.04	Toxicity Reference Value = QCE/Total AF

R Value	TRV (mg/kg-day)	Justification	Appropriate Functional Group
1	0.13	Test organism is in the same order and trophic level as the functional group members	none
2	0.06	Test organism is in a different order and same trophic level from the functional group members	M121, M122, M122A, M123, M132
3	0.04	Test organism is in a different order and trophic level from the functional group members	M210, M210A, M222, M322, M422, M422A

COPC:

Arsenic CAS 7778-43-0

Test Organisms:

Mallard (Herbivore, Order-Anseriformes)

Exposure Medium:

Oral in diet (Arsenic as sodium arsenite)

Test Endpoint:

NOAEL

Reference:

U.S. Fish and Wildlife Service. 1964. Pesticide-wildlife studies, 1963: a review of Fish and Wildlife Service investigations during the calendar year. FWS Circular 199.

QCE:

5.14 mg/kg-day ((51.35mg As/kg food)*(0.1 kg food/day))/(1kg BW)

Adjustment Factors (AF)				Justification for adjustment factor
R	1	2	3	Same trophic level but different order than members of functional groups
I	2	2	2	
Q ₁	1	1	1	Mortality, is ecologically relevant
Q ₂	1	1	1	Chronic duration (over 128 days)
Q ₃	1	1	1	NOAEL
U	2	2	2	Multiple doses (100, 250, 500, and 1000 ppm sodium arsenite) examined with both a NOAEL and a LOAEL established. However, no reproductive endpoints examined.
Total AF	4	8	12	$R * I * Q_1 * Q_2 * Q_3 * U = \text{Total AF}$
QCE (mg/kg-day)	5.14	5.14	5.14	QCE = quantified critical endpoint
TRV	1.29	0.64	0.43	Toxicity Reference Value = QCE/Total AF

R Value	TRV (mg/kg-day)	Justification	Appropriate Functional Group
1	1.29	Test organism is in the same order and trophic level as the functional group members	AV142, AV143
2	0.64	Test organism is in a different order and same trophic level from the functional group members	AV121, AV122, AV132
3	0.43	Test organism is in a different order and trophic level from the functional group members	AV210, AV210A, AV221, AV222, AV222A, AV232, AV233, AV241, AV242, AV310, AV322, AV333, AV342, AV422, AV432, AV433, AV442

COPC: Arsenic CAS 7778-43-0

Test Organisms: Dog (Omnivore, Order-Carnivora)

Exposure Medium: Diet as sodium arsenite or sodium arsenate

Test Endpoint: NOAEL

Reference: Byron, W.R., et al., 1967, "Pathologic changes in rats and dogs from two-year feeding of sodium arsenite or sodium arsenate," *Toxicology and Applied Pharmacology*, 10:132-147.

QCE: 1.28 mg/kg-day (50 mg/kg food)*(0.24 kg food /day)/(9.41 kg BW)

Adjustment Factors (AF)				Justification for adjustment factor
R	1	2	3	R = 1 is AF for same order and trophic level R = 2 is AF for different order and same trophic level R = 3 is AF for different order and trophic level
I	2	2	2	Reasonable number of males and females studied (24)
Q ₁	1	1	1	Weight loss, survival, endpoint ecologically significant
Q ₂	1	1	1	Chronic study (2 years)
Q ₃	1	1	1	NOAEL
U	2	2	2	Reasonable study, but no reproductive endpoints examined in the two years.
Total AF	4	8	12	$R * I * Q_1 * Q_2 * Q_3 * U = \text{Total AF}$
QCE (mg/kg-day)	1.28	1.28	1.28	QCE = quantified critical endpoint
TRV	0.32	0.16	0.11	Toxicity Reference Value = QCE/Total AF

R Value	TRV (mg/kg-day)	Justification	Appropriate Functional Group
1	0.32	Test organism is in the same order and trophic level as the functional group members	M422A
2	0.16	Test organism is in a different order and same trophic level from the functional group members	M422
3	0.11	Test organism is in a different order and trophic level from the functional group members	M121, M122, M122A, M123, M210, M210A, M222, M322

*Ingestion rate specified

COPC: Arsenic CAS 7778-43-0

Test Organisms: Rat (Omnivore, Order-Rodentia)

Exposure Medium: Diet as sodium arsenate or sodium arsenite

Test Endpoint: NOAEL

Reference: Byron, W.R., et al., 1967, "Pathologic changes in rats and dogs from two-year feeding of sodium arsenite or sodium arsenate," *Toxicology and Applied Pharmacology*, 10:132-147.

QCE: 3.1mg/kg-day (62.5 mg/kg food)*(0.0189kg/day)/(0.382 kg BW)

Adjustment Factors (AF)				Justification for adjustment factor
R	1	2	3	Different trophic level and order than members of functional groups.
I	2	2	2	300 weanling Data do not show a good dose-response curve low-dose range.
Q ₁	1	1	1	Levels of 62.5 ppm Arsenic as arsenite and 125 ppm Arsenic as arsenate did not cause common bile duct enlargement and did not affect survival. Weight was slightly reduced in females at the 62.5 ppm Arsenic as arsenite.
Q ₂	1	1	1	Chronic study.
Q ₃	1	1	1	NOAEL using lowest NOAEL from either arsenite or arsenate
U	2	2	2	Good overall design, but no reproductive studies in the two years.
Total AF	4	8	12	$R * I * Q_1 * Q_2 * Q_3 * U = \text{Total AF}$
QCE (mg/kg-day)	3.1	3.1	3.1	QCE = quantified critical endpoint
TRV	0.78	0.39	0.26	Toxicity Reference Value = QCE/Total AF

R Value	TRV (mg/kg-day)	Justification	Appropriate Functional Group
1	0.78	Test organism is in the same order and trophic level as the functional group members	none
2	0.39	Test organism is in a different order and same trophic level from the functional group members	M422, M422A
3	0.27	Test organism is in a different order and trophic level from the functional group members	M122, M122A, M121, M123, M132 M210, M210A, M222, M322

COPC: Arsenic CAS 7778-43-0

Test Organisms: Mice (Omnivore, Order-Rodentia)

Exposure Medium: Diet as sodium arsenate or sodium arsenite

Test Endpoint: LOAEL

Reference: Schroeder, H.A., and M. Mitchner, 1971. *Toxic effects of trace elements on the reproduction of mice and rats*. Arch. Environ. Health. 23:102-106.

QCE: 1.25 mg/kg-day $((5.00 \text{ mg As/L H}_2\text{O}) \cdot (0.0075 \text{ L/day})) / (0.003 \text{ kg BW})$

Adjustment Factors (AF)				Justification for adjustment factor
R	1	2	3	Different trophic level and order than members of functional groups.
I	2	2	2	3 generations, however only one dosage
Q ₁	1	1	1	Declining litter sized with each successive generation
Q ₂	1	1	1	Chronic study.
Q ₃	2	2	2	LOAEL
U	2	2	2	Only one dose level, no NOAEL established.
Total AF	8	16	24	$R \cdot I \cdot Q_1 \cdot Q_2 \cdot Q_3 \cdot U = \text{Total AF}$
QCE (mg/kg-day)	1.25	1.25	1.25	QCE = quantified critical endpoint
TRV	0.16	0.08	0.052	Toxicity Reference Value = QCE/Total AF

R Value	TRV (mg/kg-day)	Justification	Appropriate Functional Group
1	0.16	Test organism is in the same order and trophic level as the functional group members	none
2	0.08	Test organism is in a different order and same trophic level from the functional group members	M422, M422A
3	0.052	Test organism is in a different order and trophic level from the functional group members	M122, M122A, M121, M123, M132 M210, M210A, M222, M322

COPC: Barium CAS 7440-39-3

Test Organisms: Dog (Omnivore, Order-Carnivora)

Exposure Medium: Oral

Test Endpoint: FEL LD-100

Reference: Venugopal, B., and T.D. Luckey, 1978, The Toxicity of Metals in Mammals, Plenum Press, New York.

QCE: 59 mg/kg-day

Adjustment Factors (AF)				Justification for adjustment factor
R	1	2	3	R = 1 is AF for same order and trophic level R = 2 is AF for different order and same trophic level R = 3 is AF for different order and trophic level
I	3	3	3	No information (secondary source)
Q ₁	1	1	1	Endpoint expected to be ecologically significant (mortality).
Q ₂	3	3	3	Acute study
Q ₃	3	3	3	Lethal endpoint
U	3	3	3	Acute study; no other information (secondary source)
Total AF	81	162	243	$R * I * Q_1 * Q_2 * Q_3 * U = \text{Total AF}$
QCE (mg/kg-day)	59	59	59	QCE = quantified critical endpoint
TRV	0.73	0.36	0.24	Toxicity Reference Value = QCE/Total AF

R Value	TRV (mg/kg-day)	Justification	Appropriate Functional Group
1	0.73	Test organism is in the same order and trophic level as the functional group members	M422A
2	0.36	Test organism is in a different order and same trophic level from the functional group members	M422
3	0.24	Test organism is in a different order and trophic level from the functional group members	M121, M122, M122A, M123, M210, M210A, M222, M322

COPC: Barium CAS 7440-39-3

Test Organisms: Rat (Omnivore, Order-Rodentia)

Exposure Medium: Water

Test Endpoint: NEL

Reference: Perry, H.M. et al. 1989, "Hypertension and associated cardiovascular abnormalities induced by chronic barium feeding," Journal of Toxicology and Environmental Health, 28(3):373-388.
Kopp, S.J. et al. 1985, "Cardiovascular dysfunction and hypersensitivity to sodium pentobarbital induced by chronic barium chloride ingestion, Toxicology and Applied Pharmacology, 77(23):303-314.

QCE: 35.6 mg/kg-day (100 mg/L)*(0.015L/day)/0.45kg BW

Adjustment Factors (AF)				Justification for adjustment factor
R	1	2	3	R = 1 is AF for same order and trophic level R = 2 is AF for different order and same trophic level R = 3 is AF for different order and trophic level
I	1	1	1	Chronic toxicity studies with adequate numbers of animals
Q ₁	0.5	0.5	0.5	Although endpoint examined (increased blood pressure at higher doses) could occur in ecological receptors, the absence of any effects on growth and longevity at any dose argues against its ecological relevance. But at the NOAEL dose, no hypersensitivity was observed.
Q ₂	1	1	1	Chronic study (16 months)
Q ₃	1	1	1	NEL
U	1	1	1	Concordant results in several detailed studies
M	0.5	0.5	0.5	Soluble salt in the drinking water was used
Total AF	0.25	0.50	.075	$R * I * Q_1 * Q_2 * Q_3 * U * M = \text{Total AF}$
QCE (mg/kg-day)	35.6	35.6	35.6	QCE = quantified critical endpoint
TRV	142	71.2	47.5	Toxicity Reference Value = QCE/Total AF

R Value	TRV (mg/kg-day)	Justification	Appropriate Functional Group
1	142	Test organism is in the same order and trophic level as the functional group members	none
2	71.2	Test organism is in a different order and same trophic level from the functional group members	M422, M422A
3	47.5	Test organism is in a different order and trophic level from the functional group members	M121, M122, M122A, M132, M210, M210A, M222, M322

*BW given by an earlier Perry article, ingestion rate specified in the article

**note-10ppm had some adverse effects such as an increase in blood pressure and tissue concentration.

COPC: Barium Chloride CAS 10361-37-2

Test Organisms: Rat

Exposure Medium: Oral gavage

Test Endpoint: NOAEL

Reference: Borzelleca, J.F., Condie Jr., L.W. and J.L. Egle Jr., 1988, "Short-Term Toxicity (One- and Ten-Day Gavage) of Barium Chloride in Male and Female Rats", *Journal of the American College of Toxicity* 7(5): 675-685.

QCE: 209 mg/kg-day

Adjustment Factors (AF)				Justification for adjustment factor
R	1	2	3	R = 1 is AF for same order and trophic level R = 2 is AF for different order and same trophic level R = 3 is AF for different order and trophic level
I	2	2	2	Groups of males and females (10 of each sex) were formed. 1 day study received deionized water (20 ml/kg body weight) and doses of 30, 100, and 300 mg/kg. 10 day study received the same water and doses of 100, 145, 209, and 300 mg/kg.
Q ₁	1	1	1	Body weight and selected organs (brain, spleen, lungs, thymus, kidneys, and testes or ovaries) were measured.
Q ₂	3	3	3	Short-term study (1 or 10 days)
Q ₃	1	1	1	NOAEL
U	2	2	2	Good use of other supporting sources, no reproductive endpoints or sensitive life stages studied.
Total AF	12	24	36	$R * I * Q_1 * Q_2 * Q_3 * U = \text{Total AF}$
QCE (mg/kg-day)	209	209	209	QCE = quantified critical endpoint
TRV	17.4	8.71	5.81	Toxicity Reference Value = QCE/Total AF

R Value	TRV (mg/kg-day)	Justification	Appropriate Functional Group
1	17.4	Test organism is in the same order and trophic level as the functional group members	none
2	8.71	Test organism is in a different order and same trophic level from the functional group members	M422, M422A
3	5.81	Test organism is in a different order and trophic level from the functional group members	M121, M122, M122A, M132, M210, M210A, M222, M322

COPC: Benzo(a)anthracene (BaA) CAS 56-55-3

Test Organisms: Mouse (Omnivore, Order-Rodentia)

Exposure Medium: Oral (gavage solution)

Test Endpoint: FEL

Reference: Klein, M., 1963. "Susceptibility of strain B6AF/j hybrid infant mice to tumorigenesis with 1,2-benzoanthracene, deoxycholic acid, and 3-methylcholanthrene," *Cancer Research*, 23:1701-1707.

QCE: 50 mg/kg-day (22.5 mg/mouse-total)*(1 mouse/0.03125 kg BW)*(total dose/15 days)

Adjustment Factors (AF)				Justification for adjustment factor
R	1	2	3	R = 1 is AF for same order and trophic level R = 2 is AF for different order and same trophic level R = 3 is AF for different order and trophic level
I	2	2	2	Infant males tested. No females tested.
Q ₁	0.1	0.1	0.1	Cancer endpoint
Q ₂	1	1	1	Long-term (547-day) study
Q ₃	3	3	3	FEL
U	3	3	3	Statistical evaluation of data not reported.
Total AF	1.8	3.6	5.4	$R * I * Q_1 * Q_2 * Q_3 * U = \text{Total AF}$
QCE (mg/kg-day)	50	50	50	QCE = quantified critical endpoint
TRV	28	14	9.3	Toxicity Reference Value = QCE/Total AF

R Value	TRV (mg/kg-day)	Justification	Appropriate Functional Group
1	28	Test organism is in the same order and trophic level as the functional group members	none
2	14	Test organism is in a different order and same trophic level from the functional group members	M422, M422A
3	9.3	Test organism is in a different order and trophic level from the functional group members	M121, M122, M122A, M132, M210, M210A, M222, M322

*22.5 specified in article

**BW given in Dames and Moore Animal Data Table

***Dose was given 3 days/week for 5 weeks = 15 days

COPC: Benzo(a)pyrene CAS 50-32-8

Test Organisms: Mouse (Omnivore, Order-Rodentia)

Exposure Medium: Oral (gavage)

Test Endpoint: FEL

Reference: Klein, M., 1963. "Susceptibility of Strain B6AF/j Hybrid Infant Mice to Tumorigenesis with 1,2-Benxanthracene, deoxycyclic acid, and 3-methylcholanthrene", *Cancer Research*, 23:1701-1707.

QCE: 500 mg/kg-day

Adjustment Factors (AF)				Justification for adjustment factor
R	1	2	3	R = 1 is AF for same order and trophic level R = 2 is AF for different order and same trophic level R = 3 is AF for different order and trophic level
I	2	2	2	Infant males tested.
Q ₁	0.1	0.1	0.1	Cancer endpoint
Q ₂	1	1	1	Chronic (547-day) study
Q ₃	3	3	3	FEL
U	3	3	3	Statistical evaluation of data not reported. Number of animals tested not reported.
Total AF	1.8	3.6	5.4	$R * I * Q_1 * Q_2 * Q_3 * U = \text{Total AF}$
QCE (mg/kg-day)	500	500	500	QCE = quantified critical endpoint
TRV	278	139	92.6	Toxicity Reference Value = QCE/Total AF

R Value	TRV (mg/kg-day)	Justification	Appropriate Functional Group
1	278	Test organism is in the same order and trophic level as the functional group members	none
2	139	Test organism is in a different order and same trophic level from the functional group members	M422, M422A
3	92.6	Test organism is in a different order and trophic level from the functional group members	M121, M122, M122A, M132, M210, M210A, M222, M322

COPC: Cadmium CAS 7440-43-9

Test Organisms: Chicken (Omnivore, Order-Galliformes)

Exposure Medium: Diet

Test Endpoint: LOAEL Body weight gain, mortality

Reference: Pritzel, M.C., Y.H. Lie, E.W. Kienholz, and C.E. Whiteman, 1974, *The Effect of Dietary Cadmium on the Development of Young Chickens*, Poultry Sci. 53:2026-2029.

QCE: 29 mg/kg-day (400mg/kg)*(0.11kg/day)/0.151 kg bw

Adjustment Factors (AF)				Justification for adjustment factor
R	1	2	3	R = 1 is AF for same order and trophic level R = 2 is AF for different order and same trophic level R = 3 is AF for different order and trophic level
I	2	2	2	Adequate numbers of males tested, 100
Q ₁	1	1	1	Endpoint ecologically relevant (growth, mortality).
Q ₂	2	2	2	Subchronic study
Q ₃	3	3	3	LOAEL endpoint, but mortality observed
U	3	3	3	No reproductive endpoints examined, however, sensitive life stage examined. High doses tested. Presence of zinc in diet may have influenced (decreased) cadmium toxicity. NOAEL not identified.
Total AF	36	72	108	$R * I * Q_1 * Q_2 * Q_3 * U = \text{Total AF}$
QCE (mg/kg-day)	29	29	29	QCE = quantified critical endpoint
TRV	0.81	0.40	0.27	Toxicity Reference Value = QCE/Total AF

R Value	TRV (mg/kg-day)	Justification	Appropriate Functional Group
1	0.81	Test organism is in the same order and trophic level as the functional group members	none
2	0.40	Test organism is in a different order and same trophic level from the functional group members	AV422, AV432, AV433, AV442
3	0.27	Test organism is in a different order and trophic level from the functional group members	AV121, AV122, AV132, AV142, AV143, AV210, AV210A, AV221, AV222, AV222A, AV232, AV233, AV241, AV242, AV310, AV322, AV333, AV342

*Ingestion rate specified

**BW estimated through the Rosomer article, 1961.

COPC: Cadmium CAS 7440-43-9

Test Organisms: Black Duck (Herbivore, Order-Anseriformes)

Exposure Medium: Diet

Test Endpoint: LOAEL

Reference: Heinz, G.H. and Haseltine, S.D., 1983, "Altered Avoidance Behavior of Young Black Ducks Fed Cadmium". *Environ. Toxicol. Chem.* 2:419-421. As cited in Eisler, 1985.

QCE: 0.14 mg/kg-day (4 mg/kg)*(0.06 kg/day)/1.7 kg BW

Adjustment Factors (AF)				Justification for adjustment factor
R	1	2	3	R = 1 is AF for same order and trophic level R = 2 is AF for different order and same trophic level R = 3 is AF for different order and trophic level
I	1	1	1	Adequate numbers tested, males, females and juveniles given the doses.
Q ₁	1	1	1	Ecologically relevant endpoint (behavior).
Q ₂	1	1	1	Chronic (90-day) exposure
Q ₃	2	2	2	LOAEL endpoint
U	2	2	2	Reproductive endpoints and sensitive life stage examined, but only data given was on the flight response of the juveniles.
M	0.5	0.5	0.5	Cadmium chloride in the feed
Total AF	2	4	6	$R * I * Q_1 * Q_2 * Q_3 * U = \text{Total AF}$
QCE (mg/kg-day)	0.14	0.14	0.14	QCE = quantified critical endpoint
TRV	0.07	0.04	0.2	Toxicity Reference Value = QCE/Total AF

R Value	TRV (mg/kg-day)	Justification	Appropriate Functional Group
1	0.07	Test organism is in the same order and trophic level as the functional group members	AV142, AV143
2	0.04	Test organism is in a different order and same trophic level from the functional group members	AV121, AV122, AV132
3	0.02	Test organism is in a different order and trophic level from the functional group members	AV210, AV210A, AV221, AV222, AV222A, AV232, AV233, AV242, AV310, AV322, AV333, AV342, AV422, AV432, AV433, AV442

COPC: Cadmium CAS 7440-43-9

Test Organisms: Rat (Omnivore, Order-Rodentia)

Exposure Medium: Diet

Test Endpoint: LOAEL

Reference: Wills, J.H., Groblewski, G.E., Coulston, F., 1981, *Chronic and Multigeneration Toxicities of Small Concentrations of Cadmium in the Diet of Rats*, Ecotoxicol. Environ. Safety. 5:452-464.
ATSDR, Agency for Toxic Substance Disease Registry, 1989, *Toxicological Profile for Cadmium*, March, 1989.

QCE: 5.5 E-3 mg/kg-day Specified

Adjustment Factors (AF)				Justification for adjustment factor
R	1	2	3	R = 1 is AF for same order and trophic level R = 2 is AF for different order and same trophic level R = 3 is AF for different order and trophic level
I	1	1	1	Adequate numbers of males females and juveniles tested.
Q ₁	1	1	1	Ecologically relevant endpoint (growth, mortality).
Q ₂	1	1	1	Chronic study
Q ₃	2	2	2	LOAEL
U	1	1	1	Excellent design, four-generational study.
Total AF	2	4	6	$R * I * Q_1 * Q_2 * Q_3 * U = \text{Total AF}$
QCE (mg/kg-day)	5.5E-3	5.5E-3	5.5E-3	QCE = quantified critical endpoint
TRV	3E-3	1E-3	8E-4	Toxicity Reference Value = QCE/Total AF

R Value	TRV (mg/kg-day)	Justification	Appropriate Functional Group
1	3E-3	Test organism is in the same order and trophic level as the functional group members	none
2	1E-3	Test organism is in a different order and same trophic level from the functional group members	M422, M422A
3	8E-4	Test organism is in a different order and trophic level from the functional group members	M121, M122, M122A, M132, M210, M210A, M222, M322

COPC: Chromium(III) CAS 7440-47-3

Test Organisms: Rat (Omnivore, Order-Rodentia)

Exposure Medium: Diet

Test Endpoint: NOAEL

Reference: Ivankovic and Preussmann, 1975, *Absence of Toxic and Carcinogenic Effects After Administration of High Doses of Chromic Oxide Pigment in Subacute and Long-Term Feeding Experiments in Rats*, Food Cosmet. Toxicol., 13(3): 347-351.

QCE: 1500 mg/kg-day 1800 g/kg total dose consumed at highest dose rate, administered 5 days/week for 120 weeks (~840 days total), corrected for % Cr.

Adjustment Factors (AF)				Justification for adjustment factor
R	1	2	3	R = 1 is AF for same order and trophic level R = 2 is AF for different order and same trophic level R = 3 is AF for different order and trophic level
I	1	1	1	Chronic toxicity study with adequate numbers of animals
Q ₁	1	1	1	No endpoint affected (treatments had no effect on life expectancy, food consumption, growth rate, or cancer incidence).
Q ₂	1	1	1	Chronic study
Q ₃	1	1	1	NOAEL endpoint
U	2	2	2	Large chronic study
Total AF	2	4	6	$R * I * Q_1 * Q_2 * Q_3 * U = \text{Total AF}$
QCE (mg/kg-day)	1500	1500	1500	QCE = quantified critical endpoint
TRV	750	375	250	Toxicity Reference Value = QCE/Total AF

R Value	TRV (mg/kg-day)	Justification	Appropriate Functional Group
1	750	Test organism is in the same order and trophic level as the functional group members	none
2	375	Test organism is in a different order and same trophic level from the functional group members	M422, M422A
3	250	Test organism is in a different order and trophic level from the functional group members	M121, M122, M122A, M132, M210, M210A, M222, M322

COPC:**Chromium (III) CAS 7440-47-3****Test Organisms:**

Chicken (Omnivore, Order-Galliformes)

Exposure Medium:

Diet

Test Endpoint:

NOAEL

Reference:Romoser, G.L., W.A. Dudley, L.J. Machlin, and L. Loveless, 1961, *Toxicity of Vanadium and Chromium for the Growing Chick*, Poultry Science, 40:1171-1173.**QCE:**

49 mg/kg-day

Adjustment Factors (AF)				Justification for adjustment factor
R	1	2	3	R = 1 is AF for same order and trophic level R = 2 is AF for different order and same trophic level R = 3 is AF for different order and trophic level
I	2	2	2	Primary source available
Q ₁	1	1	1	Ecologically relevant endpoint (growth, mortality).
Q ₂	2	2	2	Subchronic exposure duration
Q ₃	1	1	1	NOAEL endpoint
U	3	3	3	Old study, limited endpoints
Total AF	12	24	36	$R * I * Q_1 * Q_2 * Q_3 * U = \text{Total AF}$
QCE (mg/kg-day)	49	49	49	QCE = quantified critical endpoint
TRV	4.1	2.0	1.4	Toxicity Reference Value = QCE/Total AF

R Value	TRV (mg/kg-day)	Justification	Appropriate Functional Group
1	4.1	Test organism is in the same order and trophic level as the functional group members	none
2	2.0	Test organism is in a different order and same trophic level from the functional group members	AV422, AV432, AV433, AV442
3	1.4	Test organism is in a different order and trophic level from the functional group members	AV121, AV122, AV132, AV142, AV143, AV210, AV210A, AV221, AV222, AV222A, AV232, AV233, AV241, AV242, AV310, AV322, AV333, AV342

COPC: Chrysene CAS 218-01-9

Test Organisms: Mouse (Omnivore, Order-Rodentia)

Exposure Medium: Dermal

Test Endpoint: LOAEL

Reference: Hecht, S.S., Bondinell, W.E., Hoffmann, D., 1974. "Chrysene and methylchrysenes: Presence in tobacco smoke and carcinogenicity" *J. Nat. Cancer Inst.*, 53:1121-1133.
US Department of Health and Human Services, Public Health Service, Agency for Toxic Substances and Disease Registry, 1990, *Toxicological Profile for Chrysene*, March.

QCE: 1.2 mg/kg-day

Adjustment Factors (AF)				Justification for adjustment factor
R	1	2	3	R = 1 is AF for same order and trophic level R = 2 is AF for different order and same trophic level R = 3 is AF for different order and trophic level
I	2	2	2	20 female Swiss mice (Ha/ICR/Mil).
Q ₁	1	1	1	Endpoint of relevant ecological significance
Q ₂	1	1	1	Chronic (Applied 3 times weekly for 17 months)
Q ₃	2	2	2	LOAEL endpoint - benign and malignant skin tumors
U	3	3	3	Limited information supplied in ATSDR reference. No results of the control group or supporting data, dose estimated from topical application.
Total AF	12	24	36	$R * I * Q_1 * Q_2 * Q_3 * U = \text{Total AF}$
QCE (mg/kg-day)	1.2	1.2	1.2	QCE = quantified critical endpoint
TRV	0.10	0.05	0.03	Toxicity Reference Value = QCE/Total AF

R Value	TRV (mg/kg-day)	Justification	Appropriate Functional Group
1	0.10	Test organism is in the same order and trophic level as the functional group members	none
2	0.05	Test organism is in a different order and same trophic level from the functional group members	M422, M422A
3	0.03	Test organism is in a different order and trophic level from the functional group members	M121, M122, M122A, M132, M210, M210A, M222, M322

COPC: Cobalt (cobalt chloride) CAS 7440-48-4

Test Organisms: Chicken (Omnivore, Order-Galliformes)

Exposure Medium: Diet

Test Endpoint: LOAEL Increased mortality associated with *S. gallinarium* infection

Reference: Hill, C.H., 1979, "The effect of dietary protein levels on mineral toxicity in chicks," Journal of Nutrition, 109:501-507.

QCE: 10.2 mg/kg-day 100 ppm in diet converted to dose using an ingestion rate* of 0.02 kg/day and estimated body weight of 0.2kg from study.

Adjustment Factors (AF)				Justification for adjustment factor
R	1	2	3	R = 1 is AF for same order and trophic level R = 2 is AF for different order and same trophic level R = 3 is AF for different order and trophic level
I	2	2	2	Adequate numbers of animals, but variability not addressed.
Q ₁	1	1	1	Endpoint ecologically relevant
Q ₂	2	2	2	Subchronic duration
Q ₃	2	2	2	LOAEL
U	2	2	2	No reproductive endpoints examined, but sensitive life stage evaluated
Total AF	16	32	48	$R * I * Q_1 * Q_2 * Q_3 * U = \text{Total AF}$
QCE (mg/kg-day)	10.2	10.2	10.2	QCE = quantified critical endpoint
TRV	0.638	0.319	0.213	Toxicity Reference Value = QCE/Total AF

R Value	TRV (mg/kg-day)	Justification	Appropriate Functional Group
1	0.638	Test organism is in the same order and trophic level as the functional group members	none
2	0.319	Test organism is in a different order and same trophic level from the functional group members	AV422, AV432, AV433, AV442
3	0.213	Test organism is in a different order and trophic level from the functional group members	AV121, AV122, AV132, AV142, AV143, AV210, AV210A, AV221, AV222, AV222A, AV232, AV233, AV241, AV242, AV310, AV322, AV333, AV342

* Estimated as $0.0582 \text{ Wt}^{0.651}$ (kg) as cited in EPA, 1993. Wildlife Exposure Factors Handbook.

COPC: Cobalt CAS 7440-48-4

Test Organisms: Dog (Omnivore, Order-Carnivora)

Exposure Medium: Diet

Test Endpoint: NOAEL

Reference: Brewer, B., 1940, "A statistical study of cobalt polycythemia in the dog," Am. J. Physiol. 128:345-348.
Agency for Toxic Substance Disease Registry (ATSDR), 1990, Draft: Toxicological Profile for Cobalt, October.

QCE: 5.0 mg/kg-day Specified

Adjustment Factors (AF)				Justification for adjustment factor
R	1	2	3	R = 1 is AF for same order and trophic level R = 2 is AF for different order and same trophic level R = 3 is AF for different order and trophic level
I	2	2	2	Only females tested, 7 total dogs.
Q ₁	0.1	0.1	0.1	Endpoint of unknown ecological significance
Q ₂	2	2	2	Subchronic duration (4 weeks)
Q ₃	1	1	1	NOAEL
U	3	3	3	Older study, reasonable design, no reproductive endpoints or sensitive life stage examined.
Total AF	1.2	2.4	3.6	$R * I * Q_1 * Q_2 * Q_3 * U = \text{Total AF}$
QCE (mg/kg-day)	5	5	5	QCE = quantified critical endpoint
TRV	4.2	2.1	1.4	Toxicity Reference Value = QCE/Total AF

R Value	TRV (mg/kg-day)	Justification	Appropriate Functional Group
1	4.2	Test organism is in the same order and trophic level as the functional group members	M422A
2	2.1	Test organism is in a different order and same trophic level from the functional group members	M422
3	1.4	Test organism is in a different order and trophic level from the functional group members	M121, M122, M122A, M123, M210, M210A, M222, M322

COPC:**Cobalt** CAS 7440-48-4**Test Organisms:**

Rat (Omnivore, Order-Rodentia)

Exposure Medium:

Diet

Test Endpoint:

NOAEL

Reference:

Nation, J.R., Bourgeois, A.E., Clark, D.E. et al., 1983, "The effects of chronic cobalt exposure on behavior and metallothionein levels in the adult rat," Neurobehav. Toxicol. and Teratology, 5:9-15.

Agency for Toxic Substance Disease Registry (ATSDR), 1990, Draft: Toxicological Profile for Cobalt, October.

QCE:

5 mg/kg-day Specified

Adjustment Factors (AF)				Justification for adjustment factor
R	1	2	3	R = 1 is AF for same order and trophic level R = 2 is AF for different order and same trophic level R = 3 is AF for different order and trophic level
I	3	3	3	Small number of male rats tested (18)
Q ₁	1	1	1	Endpoint of relevant ecological significance
Q ₂	2	2	2	Subchronic duration
Q ₃	1	1	1	NOAEL endpoint
U	2	2	2	Reasonable study, but sensitive life stage not examined
Total AF	12	24	36	$R * I * Q_1 * Q_2 * Q_3 * U = \text{Total AF}$
QCE (mg/kg-day)	5	5	5	QCE = quantified critical endpoint
TRV	0.42	0.21	0.14	Toxicity Reference Value = QCE/Total AF

R Value	TRV (mg/kg-day)	Justification	Appropriate Functional Group
1	0.42	Test organism is in the same order and trophic level as the functional group members	none
2	0.21	Test organism is in a different order and same trophic level from the functional group members	M422, M422A
3	0.14	Test organism is in a different order and trophic level from the functional group members	M121, M122, M122A, M132, M210, M210A, M222, M322

COPC: Copper CAS 7440-50-8

Test Organisms: Chicken (Omnivore, Order-Galliformes)

Exposure Medium: Oral in diet (copper oxide)

Test Endpoint: NOAEL

Reference: Mehring, A.L., Jr., et al., 1960, 'The Tolerance of Growing Chicken for Dietary Copper'. *Poultry Sci.* 39:713-719.

QCE: 55.3 mg/kg-day

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R	1	2	3	R = 1 is AF for same order and trophic level R = 2 is AF for different order and same trophic level R = 3 is AF for different order and trophic level
I	1	1	1	Eleven dose levels during critical growth period, growth, mortality-for 10 weeks.
Q ₁	2	2	2	Mortality
Q ₂	1	1	1	Chronic exposure duration
Q ₃	1	1	1	NOAEL
U	2	2	2	
Total AF	4	8	12	$R * I * Q_1 * Q_2 * Q_3 * U = \text{Total AF}$
QCE (mg/kg-day)	55.3	55.3	55.3	QCE = quantified critical endpoint
TRV	13.8	6.91	4.61	Toxicity Reference Value = QCE/Total AF

R Value	TRV (mg/kg-day)	Justification	Appropriate Functional Group
1	13.8	Test organism is in the same order and trophic level as the functional group members	None
2	6.91	Test organism is in a different order and same trophic level from the functional group members	AV422, AV432, AV433, AV442
3	4.61	Test organism is in a different order and trophic level from the functional group members	AV121, AV122, AV132, AV142, AV143, AV210, AV210A, AV221, AV222, AV222A, AV232, AV233, AV241, AV242, AV310, AV322, AV333, AV342

COPC: Copper CAS 7440-50-8

Test Organisms: Chicken (Omnivore, Order-Galliformes)

Exposure Medium: Diet

Test Endpoint: NOAEL

Reference: Stevenson, M.H., and N. Jackson, 1981, "An Attempt to Distinguish Between the Direct and Indirect Effects, in the Laying Domestic Fowl, of Added Dietary Sulfate", *British Journal of Nutrition*, 46(1):71-76.

QCE: 1006 mg/kg-day [1408 mg Cu/day/1.4 kg BW]**

Adjustment Factors (AF)				Justification for adjustment factor
R	1	2	3	R = 1 is AF for same order and trophic level R = 2 is AF for different order and same trophic level R = 3 is AF for different order and trophic level
I	3	3	3	Rather small group sizes (n=6)
Q ₁	1	1	1	Endpoints are body weight, food intake, egg production, hepatic metals concentrations. Ecologically relevant endpoint
Q ₂	2	2	2	Subchronic duration
Q ₃	1	1	1	NOAEL endpoint
U	2	2	2	Subchronic exposure and small group sizes, but detailed characterization of relevant endpoints.
Total AF	12	24	36	$R * I * Q_1 * Q_2 * Q_3 * U = \text{Total AF}$
QCE (mg/kg-day)	1006	1006	1006	QCE = quantified critical endpoint
TRV	83.83	41.92	27.89	Toxicity Reference Value = QCE/Total AF

R Value	TRV (mg/kg-day)	Justification	Appropriate Functional Group
1	83.83	Test organism is in the same order and trophic level as the functional group members	none
2	41.92	Test organism is in a different order and same trophic level from the functional group members	AV422, AV432, AV433, AV442
3	27.89	Test organism is in a different order and trophic level from the functional group members	AV121, AV122, AV132, AV142, AV143, AV210, AV210A, AV221, AV222, AV222A, AV232, AV233, AV241, AV242, AV310, AV322, AV333, AV342

*Ingestion rate and body weight specified in article

COPC: Copper CAS 7440-50-8
(as copper sulfate)

Test Organisms: Mink (Carnivore, Order-Carnivora)

Exposure Medium: Diet

Test Endpoint: NOAEL

Reference: Aulerich, R.J., et al., 1982, *Effects of Supplemental Dietary Copper on Growth, Reproductive Performance and Kit Survival of Standard Dark Mink and the Acute Toxicity of Copper to Mink*, Journal of Animal Science, 55(2):337-43.

QCE: 7.87 mg/kg-day

Adjustment Factors (AF)				Justification for adjustment factor
R	1	2	3	R = 1 is AF for same order and trophic level R = 2 is AF for different order and same trophic level R = 3 is AF for different order and trophic level
I	3	3	3	Group sizes were small relative to observed variation in responses
Q ₁	1	1	1	Ecologically relevant endpoint
Q ₂	1	1	1	Chronic exposure
Q ₃	1	1	1	NOAEL endpoint
U	2	2	2	Parameters observed were relevant but not exhaustive
Total AF	6	12	18	$R * I * Q_1 * Q_2 * Q_3 * U = \text{Total AF}$
QCE (mg/kg-day)	7.87	7.87	7.87	QCE = quantified critical endpoint
TRV	1.31	0.656	0.437	Toxicity Reference Value = QCE/Total AF

R Value	TRV (mg/kg-day)	Justification	Appropriate Functional Group
1	1.31	Test organism is in the same order and trophic level as the functional group members	M322
2	0.656	Test organism is in a different order and same trophic level from the functional group members	none
3	0.437	Test organism is in a different order and trophic level from the functional group members	M121, M122, M122A, M123, M210, M210A, M222, M422, M422A

COPC: Copper CAS 7440-50-8

Test Organisms: Rat (F334/N) (Omnivore, Order-Rodentia)

Exposure Medium: Diet

Test Endpoint: NOAEL

Reference: Hebert, C.D., et al., 1993, *Subchronic Toxicity of Cupric Sulfate Administered in Drinking Water and Feed to Rats and Mice*, Fundamentals and Applied Toxicology, 21:461-475.

QCE: 66 mg/kg-day

Adjustment Factors (AF)				Justification for adjustment factor
R	1	2	3	R = 1 is AF for same order and trophic level R = 2 is AF for different order and same trophic level R = 3 is AF for different order and trophic level
I	3	3	3	Males appeared to be more sensitive than females
Q ₁	1	1	1	Ecologically relevant endpoint
Q ₂	2	2	2	Subchronic exposure
Q ₃	1	1	1	NOAEL endpoint
U	2	2	2	Thorough and well-designed study, but subchronic duration prevented evaluation of long-term effects, e.g., development of tolerance as reported by others.
Total AF	12	24	36	$R * I * Q_1 * Q_2 * Q_3 * U = \text{Total AF}$
QCE (mg/kg-day)	66	66	66	QCE = quantified critical endpoint
TRV	5.5	2.8	1.8	Toxicity Reference Value = QCE/Total AF

R Value	TRV (mg/kg-day)	Justification	Appropriate Functional Group
1	5.5	Test organism is in the same order and trophic level as the functional group members	none
2	2.8	Test organism is in a different order and same trophic level from the functional group members	M422, M422A
3	1.8	Test organism is in a different order and trophic level from the functional group members	M121, M122, M122A, M132, M210, M210A, M222, M322

COPC:**Lead** CAS 7439-92-1**Test Organisms:**

Rat (Omnivore, Order-Rodentia)

Exposure Medium:

Oral in diet as lead acetate

Test Endpoint:

NOAEL

Reference:

Azar, A., H.J. Trochimowicz, M.E. Maxfield, 1973, "Review of Lead Studies in Animals Carried Out at Haskell Laboratory: Two-Year Feeding Study and Response to Hemorrhage Study", In *Environmental Health Aspects of Lead: Proceedings, International Symposium*, D. Barth et al. (ed.) Commission of European Communities, pp 199-210.

QCE:

8.0 mg/kg-day (100 mg/kg food)*(.028 kg/day)/0.35 kg BW

Adjustment Factors (AF)				Justification for adjustment factor
R	1	2	3	R = 1 is AF for same order and trophic level R = 2 is AF for different order and same trophic level R = 3 is AF for different order and trophic level
I	1	1	1	50 male and 50 female rats per dose level. Reproductive three generation (during critical life stage) study.
Q ₁	1	1	1	Mortality, # of tumors, weight gain, # of pregnancies, # of pups born alive, fertility index, gestation index, viability index or lactation index. Ecologically relevant endpoint.
Q ₂	1	1	1	Chronic
Q ₃	1	1	1	NOAEL
U	1	1	1	Pb as lead acetate was fed for a three-generation six-litter study at multiple dosages (0, 10, 50, 100, 1000, 2000 ppm). At 1000 and 2000 ppm dietary Pb, the average weight of weanling rats was slightly decreased. At 10 ppm stippled cells were increased. A decrease in ALAD activity was seen at 50 ppm (however these are not considered adverse effects). 100 ppm Pb is considered the NOAEL.
Total AF	1	2	3	$R * I * Q_1 * Q_2 * Q_3 * U = \text{Total AF}$
QCE (mg/kg-day)	8.0	8.0	8.0	QCE = quantified critical endpoint
TRV	8.0	4.0	2.7	Toxicity Reference Value = QCE/Total AF

R Value	TRV (mg/kg-day)	Justification	Appropriate Functional Group
1	8.0	Test organism is in the same order and trophic level as the functional group members	None
2	4.0	Test organism is in a different order and same trophic level from the functional group members	M422, M422A
3	2.7	Test organism is in a different order and trophic level from the functional group members	M121, M122, M122A, M132, M210, M210A, M222, M322

*ingestion rate and BW taken from data table for animals

COPC: Lead CAS 7439-92-1

Test Organisms: Beagle Dog (Omnivore, Order-Carnivora)

Exposure Medium: Diet as lead acetate

Test Endpoint: NOAEL

Reference: Azar, A., H.J. Trochimowicz, M.E. Maxfield, 1973, "Review of Lead Studies in Animals Carried Out at Haskell Laboratory: Two-Year Feeding Study and Response to Hemorrhage Study", In *Environmental Health Aspects of Lead: Proceedings, International Symposium*, D. Barth et al. (ed.) Commission of European Communities, pp 199-210.

QCE: 13 mg/kg-day (500 mg/kg food)*(0.24kg/day)/9.41 kg BW

Adjustment Factors (AF)				Justification for adjustment factor
R	1	2	3	R = 1 is AF for same order and trophic level R = 2 is AF for different order and same trophic level R = 3 is AF for different order and trophic level
1	2	2	2	Four male and four female beagle dogs were used at each dose level (0, 10, 50, 100 and 500 ppm). Two year study. Average variability.
Q ₁	1	1	1	Food consumption, growth, mortality, blood level and behavior. Ecologically relevant endpoint.
Q ₂	1	1	1	Chronic
Q ₃	1	1	1	NOAEL
U	2	2	2	There was no significant effects on appearance, behavior, weight gain, mortality, or neurologic examination of dogs to 500 ppm. A decrease in ALAD activity was seen at 100 ppm. Further study concluded that while ALAD is essential to the synthesis of hemoglobin, the amt needed is but a small fraction of that normally present and this is not an adverse effect. Lack of reproductive endpoint.
Total AF	4	8	16	$R * I * Q_1 * Q_2 * Q_3 * U = \text{Total AF}$
QCE (mg/kg-day)	13	13	13	QCE = quantified critical endpoint
TRV	3.3	1.6	0.81	Toxicity Reference Value = QCE/Total AF

R Value	TRV (mg/kg-day)	Justification	Appropriate Functional Group
1	3.3	Test organism is in the same order and trophic level as the functional group members	M422A
2	1.6	Test organism is in a different order and same trophic level from the functional group members	M422
3	0.81	Test organism is in a different order and trophic level from the functional group members	M121, M122, M122A, M132, M210, M210A, M222, M322

*ingestion rate and BW taken from data table for animals

COPC: Lead CAS 7439-92-1

Test Organisms: Chicken (Omnivore, Order-Galliformes)

Exposure Medium: Diet

Test Endpoint: NOAEL

Reference: Eisler, R., 1988, *Lead Hazards to Fish, Wildlife, and Invertebrates: A Synoptic Review*, Fish and Wildlife Service. Bio. Rep. No. 14. April, 1985.

QCE: 26 mg/kg-day 500 mg/kg in diet converted to dose by multiplying by 0.105 kg/day ingestion rate and dividing by 2 kg BW

Adjustment Factors (AF)				Justification for adjustment factor
R	1	2	3	R = 1 is AF for same order and trophic level R = 2 is AF for different order and same trophic level R = 3 is AF for different order and trophic level
I	3	3	3	Secondary source
Q ₁	1	1	1	Endpoint ecologically relevant (growth)
Q ₂	2	2	2	Subchronic study
Q ₃	1	1	1	NOAEL endpoint
U	3	3	3	Limited information. Dietary NOAEL appears consistent for a variety of species.
Total AF	18	36	54	$R * I * Q_1 * Q_2 * Q_3 * U = \text{Total AF}$
QCE (mg/kg-day)	26	26	26	QCE = quantified critical endpoint
TRV	1.4	0.72	0.48	Toxicity Reference Value = QCE/Total AF

R Value	TRV (mg/kg-day)	Justification	Appropriate Functional Group
1	1.4	Test organism is in the same order and trophic level as the functional group members	none
2	0.72	Test organism is in a different order and same trophic level from the functional group members	AV422, AV432, AV433, AV442
3	0.48	Test organism is in a different order and trophic level from the functional group members	AV121, AV122, AV132, AV142, AV143, AV210, AV210A, AV221, AV222, AV222A, AV232, AV233, AV241, AV242, AV310, AV322, AV333, AV342

COPC: Lead CAS 7439-92-1

Test Organisms: Bovine (Bos spp., Herbivore, Order-Artiodactyla)

Exposure Medium: Diet (in hay and grain)

Test Endpoint: LD50

Reference: Zmudski, J., et al., 1983, *Lead Poisoning in Cattle: Reassessment of the Minimum Toxic Oral Dose*, Bull. Environ. Contam. 30:435-441.

QCE: 2.7 mg/kg-day Specified

Adjustment Factors (AF)				Justification for adjustment factor
R	1	2	3	R = 1 is AF for same order and trophic level R = 2 is AF for different order and same trophic level R = 3 is AF for different order and trophic level
I	2	2	2	22 Holstein males (9-12 weeks old) weighting approx. 55 kg. were tested
Q ₁	1	1	1	Lethality
Q ₂	2	2	2	Subchronic study
Q ₃	3	3	3	Lethality endpoint, death w/in 20 d if on milk diet
U	3	3	3	Reasonable design however, pregnant ewes given 3 mg/kg (species sensitivity could be \geq) daily did not produce adverse effects (DeMayo, et. al., 1982).
Total AF	36	72	108	$R * I * Q_1 * Q_2 * Q_3 * U = \text{Total AF}$
QCE (mg/kg-day)	2.7	2.7	2.7	QCE = quantified critical endpoint
TRV	0.075	0.038	0.025	Toxicity Reference Value = QCE/Total AF

R Value	TRV (mg/kg-day)	Justification	Appropriate Functional Group
1	0.075	Test organism is in the same order and trophic level as the functional group members	none
2	0.038	Test organism is in a different order and same trophic level from the functional group members	M121, M122, M122A, M123, M132
3	0.025	Test organism is in a different order and trophic level from the functional group members	M210, M210A, M222, M322, M422, M422A

COPC:**Lead** CAS 7439-92-1**Test Organisms:**

Dog (Omnivore, Order-Carnivora)

Exposure Medium:

Diet

Test Endpoint:

FEL Chronic toxic level

Reference:DeMayo, A., et al.. 1982, *Toxic Effects of Lead and Lead Compounds on Human Health, Aquatic Life, Wildlife, Plants, and Livestock*, CRC Crit. Rev. Environ. Control 12:257-305.Rice, D.C., 1985, *Chronic Low-Lead Exposure from Birth Produces Deficits in Discrimination Reversal in Monkeys*, Toxicol. Appl. Pharmacol. 77:201-210.**QCE:**

0.32 mg/kg-day Specified

Adjustment Factors (AF)				Justification for adjustment factor
R	1	2	3	R = 1 is AF for same order and trophic level R = 2 is AF for different order and same trophic level R = 3 is AF for different order and trophic level
I	3	3	3	Tertiary source - cites a textbook
Q ₁	1	1	1	Endpoint not specified
Q ₂	1	1	1	Chronic study
Q ₃	3	3	3	FEL
U	2	2	2	Limited information. However, a chronic study in monkeys reported a similar LOAEL (0.1 mg/kg/day) for CNS effects (Rice, 1985).
Total AF	18	36	54	$R * I * Q_1 * Q_2 * Q_3 * U = \text{Total AF}$
QCE (mg/kg-day)	0.32	0.32	0.32	QCE = quantified critical endpoint
TRV	0.018	0.009	0.006	Toxicity Reference Value = QCE/Total AF

R Value	TRV (mg/kg-day)	Justification	Appropriate Functional Group
1	0.018	Test organism is in the same order and trophic level as the functional group members	M422A
2	0.009	Test organism is in a different order and same trophic level from the functional group members	M422
3	0.006	Test organism is in a different order and trophic level from the functional group members	M121, M122, M122A, M123, M210, M210A, M222, M322

COPC: Lead CAS 7439-92-1

Test Organisms: Rat (Omnivore, Order-Rodentia)
Exposure Medium: Drinking Water (Pb as lead acetate)
Test Endpoint: NOAEL
Reference: Kimmel, C.A., et al., 1980, *Chronic Low Level Lead Toxicity in the Rat. I. Maternal Toxicity and Perinatal Effects*, Toxicol. Appl. Pharmacol. 56:28-41.

QCE: 0.36 mg/kg-day Specified (5 mg/l in water, rat water intake .025 L/day/0.35 kg BW).

Adjustment Factors (AF)				Justification for adjustment factor
R	1	2	3	R = 1 is AF for same order and trophic level R = 2 is AF for different order and same trophic level R = 3 is AF for different order and trophic level
I	2	2	2	#'s of animals in control and Pb groups ranged from 60 to 148 during the pregnancy period (2 generations), from 24 to 75 pre-pregnancy, and 6 to 13 litters during post pregnancy. However, significant variation between replicates was seen, and only females (parental generation) examined.
Q ₁	1	1	1	Food % water consumption, reproductive success, and concentrations in selected tissue. Ecologically relevant endpoints.
Q ₂	1	1	1	Chronic study
Q ₃	1	1	1	NOAEL (although Pb concentrations in blood were increased in females exposed to 5 ppm toxicity was not seen at this level)
U	1	1	1	Good design, studied reproductive effects. Weanling female rats were exposed through mating, gestation and lactation (offspring then chronically). Various dose levels (0, 5, 25, 50 ppm) studied and LOAEL established. Other studies support findings. (DeMayo et al., 1982).
M	0.5	0.5	0.5	Lead acetate placed in drinking water.
Total AF	1	2	3	$R * I * Q_1 * Q_2 * Q_3 * U = \text{Total AF}$
QCE (mg/kg-day)	0.36	0.36	0.36	QCE = quantified critical endpoint
TRV	0.36	0.18	0.12	Toxicity Reference Value = QCE/Total AF

R Value	TRV (mg/kg-day)	Justification	Appropriate Functional Group
1	0.36	Test organism is in the same order and trophic level as the functional group members	none
2	0.18	Test organism is in a different order and same trophic level from the functional group members	M422, M422A
3	0.12	Test organism is in a different order and trophic level from the functional group members	M121, M122, M122A, M132, M210, M210A, M222, M322

DeMayo, A., et al., 1982, *Toxic Effects of Lead and Lead Compounds on Human Health, Aquatic Life, Wildlife, Plants, and Livestock*, CRC Crit. Rev. Environ. Control 12:257-305

COPC: Lead (Trimethyllead) CAS 7439-92-1

Test Organisms: European Starling (Insectivore, Order-Passeriformes)

Exposure Medium: Capsule

Test Endpoint: LOAEL

Reference: Osborn, D., W.J. Eney, and K.R. Bull, 1983, *The toxicity of trialkyl lead compounds to birds*, Environ. Pollut. 31A:261-275. As cited in Eisler (1987).

QCE: 2.8 mg/kg-day (0.2 mg/day)/0.070 kg BW

Adjustment Factors (AF)				Justification for adjustment factor
R	1	2	3	R = 1 is AF for same order and trophic level R = 2 is AF for different order and same trophic level R = 3 is AF for different order and trophic level
I	3	3	3	6 groups/ group sex not specified
Q ₁	1	1	1	Endpoint ecologically relevant (behavioral effects)
Q ₂	2	2	2	Subchronic study
Q ₃	2	2	2	LOAEL
U	3	3	3	Limited information: organoform of lead could impact toxicity
Total AF	36	72	108	$R * I * Q_1 * Q_2 * Q_3 * U = \text{Total AF}$
QCE (mg/kg-day)	2.8	2.8	2.8	QCE = quantified critical endpoint
TRV	0.08	0.04	0.03	Toxicity Reference Value = QCE/Total AF

R Value	TRV (mg/kg-day)	Justification	Appropriate Functional Group
1	0.08	Test organism is in the same order and trophic level as the functional group members	AV210A
2	0.04	Test organism is in a different order and same trophic level from the functional group members	AV210, AV221, AV222, AV222A, AV232, AV233, AV241, AV242
3	0.03	Test organism is in a different order and trophic level from the functional group members	AV121, AV122, AV132, AV142, AV143, AV310, AV322, AV333, AV342, AV422, AV432, AV433, AV442

COPC: Manganese CAS 7439-96-5

Test Organisms: Japanese Quail

Exposure Medium: Oral in diet

Test Endpoint: NOAEL

Reference: Laskey, J.W. and F.W. Edens, 1985, "Effects of Chronic High-Level Manganese Exposure on Male Behavior in the Japanese Quail (*Coturnix coturnix japonica*)", *Poultry Science* 64: 579-584.

QCE: 575 mg Mn/kg BW/day

Adjustment Factors (AF)				Justification for adjustment factor
R	1	2	3	R = 1 is AF for same order and trophic level R = 2 is AF for different order and same trophic level R = 3 is AF for different order and trophic level
I	3	3	3	Only one dose administered, no mention of the number of birds tested
Q ₁	1	1	1	Ecologically relevant endpoint
Q ₂	1	1	1	Chronic
Q ₃	1	1	1	NOAEL
U	3	3	3	Certain amount of food lost by birds eating behavior led to a wide range of food intake, no evidence to suggest altered locomotion as in previous studies
Total AF	9	18	27	$R * I * Q_1 * Q_2 * Q_3 * U = \text{Total AF}$
QCE (mg/kg-day)	575	575	575	QCE = quantified critical endpoint
TRV	63.9	31.9	21.3	Toxicity Reference Value = QCE/Total AF

R Value	TRV (mg/kg-day)	Justification	Appropriate Functional Group
1	63.9	Test organism is in the same order and trophic level as the functional group members	none
2	81.9	Test organism is in a different order and same trophic level from the functional group members	AV422, AV432, AV433, AV442
3	21.3	Test organism is in a different order and trophic level from the functional group members	AV121, AV122, AV132, AV142, AV143, AV210, AV210A, AV221, AV222, AV222A, AV232, AV233, AV241, AV242, AV310, AV322, AV333, AV342

COPC: Manganese CAS 7439-96-5

Test Organisms: Chicken (Omnivore, Order-Galliformes)

Exposure Medium: Diet

Test Endpoint: NOAEL

Reference: Leeson, S., and J.D. Summers, 1982, *Effect of High Dietary Levels of Supplemental Zinc, Manganese, Copper, or Iron on Broiler Performance to Three Weeks of Age and Accumulation of These Minerals in Tissue and Excreta*, Nutrition Reports Int. 591-599.
Offiong, S.A., and S.M. Abed, 1980, *Fertility, Hatchability and Malformations in Guinea Fowl Embryos as Affected by Dietary Manganese*, British Poultry Sci. 21:371-375.

QCE: 1260 mg/kg-day (880 mg/kg food)*(0.717 kg food/day-bird)*(1 bird/0.5kg)**

Adjustment Factors (AF)				Justification for adjustment factor
R	1	2	3	R = 1 is AF for same order and trophic level R = 2 is AF for different order and same trophic level R = 3 is AF for different order and trophic level
I	1	1	1	Adequate number of animals, limited variability
Q ₁	1	1	1	Ecologically relevant endpoint (growth and reproduction)
Q ₂	3	3	3	Acute 13-day study
Q ₃	1	1	1	NOAEL endpoint
U	2	2	2	Only poultry production-type endpoints were evaluated
Total AF	6	12	18	$R * I * Q_1 * Q_2 * Q_3 * U = \text{Total AF}$
QCE (mg/kg-day)	1260	1260	1260	QCE = quantified critical endpoint
TRV	210	105	70.0	Toxicity Reference Value = QCE/Total AF

R Value	TRV (mg/kg-day)	Justification	Appropriate Functional Group
1	210	Test organism is in the same order and trophic level as the functional group members	none
2	105	Test organism is in a different order and same trophic level from the functional group members	AV422, AV432, AV433, AV442
3	70.0	Test organism is in a different order and trophic level from the functional group members	AV121, AV122, AV132, AV142, AV143, AV210, AV210A, AV221, AV222, AV222A, AV232, AV233, AV241, AV242, AV310, AV322, AV333, AV342

** Ingestion rate and BW specified in Table II of the Leeson article.

COPC: Manganese CAS 7439-96-5

Test Organisms: Rat (Omnivore, Order-Rodentia)

Exposure Medium: Diet

Test Endpoint: NOAEL

Reference: Laskey, J.W., Rehnberg, G. L., and Hein, J.F., 1982, *Effects of Chronic Manganese (MN₃O₄) Exposure on Selected Reproductive Parameters in Rats*, J. Toxicol. Environ. Health 9: 677-687.
ATSDR, Agency for Toxic Substance Disease Registry, 1990, *Draft: Toxicological Profile for Manganese*, 1990.

QCE: 88 mg/kg-day 1100mg/kg food*0.028kg/day/0.35kgBW

Adjustment Factors (AF)				Justification for adjustment factor
R	1	2	3	R = 1 is AF for same order and trophic level R = 2 is AF for different order and same trophic level R = 3 is AF for different order and trophic level
I	1	1	1	Adequate numbers, males, females and juveniles tested.
Q ₁	1	1	1	Ecologically relevant endpoint (decreased testosterone levels, delayed maturation of reproductive function).
Q ₂	1	1	1	Chronic study
Q ₃	1	1	1	NOAEL endpoint
U	1	1	1	Good design, reproductive endpoints examined and the study results consistent in mice.
Total AF	1	2	3	$R * I * Q_1 * Q_2 * Q_3 * U = \text{Total AF}$
QCE (mg/kg-day)	88	88	88	QCE = quantified critical endpoint
TRV	88	44	29	Toxicity Reference Value = QCE/Total AF

R Value	TRV (mg/kg-day)	Justification	Appropriate Functional Group
1	88	Test organism is in the same order and trophic level as the functional group members	none
2	44	Test organism is in a different order and same trophic level from the functional group members	M422, M422A
3	29	Test organism is in a different order and trophic level from the functional group members	M121, M122, M122A, M132, M210, M210A, M222, M322

COPC:**Mercury (Organic) CAS 7439-97-6****Test Organisms:**

Bovine (Herbivore, Order-Artiodactyla)

Exposure Medium:

Oral in diet

Test Endpoint:

NOAEL

Reference:

Herigstad, R.R., et al., 1972, "Chronic methylmercury toxicosis in calves." J. Am. Vet. Med. Assoc. 160:173-182. (cited in National Academy of Sciences, 1980. Mineral Tolerance of Domestic Animals. Washington, DC).

QCE:

0.1 mg/kg. body weight-day (Hg as methylmercury)

Adjustment Factors (AF)				Justification for adjustment factor
R	1	2	3	R = 1 is AF for same order and trophic level R = 2 is AF for different order and same trophic level R = 3 is AF for different order and trophic level
I	3	3	3	Discussion found that the results were similar to other reported studies. However, limited number of animals, impossible to evaluate variability, only one animal per dose.
Q ₁	1	1	1	Clinical signs, lesions, and tissue residues determined (associated with methyl mercury toxicity (MMT) in calves). Endpoint relevant.
Q ₂	1	1	1	Chronic exposure (96 days)
Q ₃	1	1	1	NOAEL
U	3	3	3	Small number of animals, 5 male Holstein-Friesian calves. No reproductive endpoint or sensitive life stage examined. Test chemical is methylmercury. NOAEL & LOAEL established. However only 1 animal per level tested.
Total AF	9	18	27	$R * I * Q_1 * Q_2 * Q_3 * U = \text{Total AF}$
QCE (mg/kg-day)	0.1	0.1	0.1	QCE = quantified critical endpoint
TRV	0.01	0.006	0.004	Toxicity Reference Value = QCE/Total AF

R Value	TRV (mg/kg-day)	Justification	Appropriate Functional Group
1	0.01	Test organism is in the same order and trophic level as the functional group members	none
2	0.006	Test organism is in a different order and same trophic level from the functional group members	M121, M122, M122A, M123, M132
3	0.004	Test organism is in a different order and trophic level from the functional group members	M210, M210A, M222, M322, M422, M422A

COPC:**Mercury (Inorganic) CAS 7439-97-6****Test Organisms:**

Japanese quail (Omnivore, Order-Galliformes)

Exposure Medium:

Oral in diet

Test Endpoint:

NOAEL

Reference:Hill and Shaffner, 1976. *Sexual maturation and productivity of Japanese quail fed graded concentrations of mercuric chloride*. Poultry Science, 55:1449-1459 (cited in National Academy of Sciences, 1980. Mineral Tolerance of Domestic Animals. Washington, DC).**QCE:**

0.47 mg/kg-day

4 ppm as mercury chloride in food,

4 mg/kg*(0.015kg/day**)/0.13 kg BW***

Factors (AF)				Justification for adjustment factor
R	1	2	3	R = 1 is AF for same order and trophic level R = 2 is AF for different order and same trophic level R = 3 is AF for different order and trophic level
I	1	1	1	Adequate numbers of males and females tested. Experiment 1 used 10 groups of 10 hatchlings of P.W.R.C. Japanese quail, Experiment 2 used 10 groups of 10 hatchlings U.M.D. Japanese quail. Both experiments had comparable results.
Q ₁	1	1	1	Ecologically relevant endpoint. Reproductive endpoints such as, hatchability, egg size, fertility and egg shell thinning assessed, neurotoxicity not studied.
Q ₂	1	1	1	Chronic exposure (28 weeks)
Q ₃	1	1	1	NOAEL
U	1	1	1	Well designed study. Multiple dose levels (0, 2, 4, 8,16,& 32 ppm) with both NOAELS and LOAELS established. 4 ppm Hg as HgCl ₂ , but no neuro.
Total AF	1	2	3	$R * I * Q_1 * Q_2 * Q_3 * U = \text{Total AF}$
QCE (mg/kg-day)	0.47	0.47	0.47	QCE = quantified critical endpoint
TRV	0.47	0.24	0.16	Toxicity Reference Value = QCE/Total AF

R Value	TRV (mg/kg-day)	Justification	Appropriate Functional Group
1	0.47	Test organism is in the same order and trophic level as the functional group members	none
2	0.24	Test organism is in a different order and same trophic level from the functional group members	AV422, AV432, AV433, AV442
3	0.16	Test organism is in a different order and trophic level from the functional group members	AV121, AV122, AV132, AV142, AV143, AV210, AV210A, AV221, AV222, AV222A, AV232, AV233, AV241, AV242, AV310, AV322, AV333, AV342

* Specified as 4 ppm in feed (turkey mash) in study

** Ingestion rate estimated by Nagy (1987) allometric equation, $0.0582(\text{BW})^{0.651}$

***BW estimated by Weimeyer article (0.13 kg)

COPC:**Mercury (Inorganic) CAS 7439-97-6****Test Organisms:**

Chickens (Omnivore, Order-Galliformes)

Exposure Medium:

Oral in drinking water

Test Endpoint:

NOAEL

Reference:

Thaxton, P., L.A. Cogburn, and C.R. Parkhurst, 1973. *Dietary mercury as related to the blood chemistry in young chickens*. Poultry Science 52:1212-1214 (cited in National Academy of Sciences, 1980. Mineral Tolerance of Domestic Animals. Washington, DC).

QCE:

12.1 mg/kg-day

(125mg/L)*(0.097 kg diet/kg bw/day)*

Adjustment Factors (AF)				Justification for adjustment factor
R	1	2	3	R = 1 is AF for same order and trophic level R = 2 is AF for different order and same trophic level R = 3 is AF for different order and trophic level
I	2	2	2	Results were inconsistent, however a similar study by Parkhurst and Thaxton, 1973 ^a reported toxic effects in young boilers at 250 ppm (similar study) including growth reduction, decreased feed and water efficiencies, alterations in the sizes of certain organs, immunosuppression, & mortality at 250 ppm as LOAEL.
Q ₁	0.5	0.5	0.5	Study determined minor effects of dietary Hg on plasma levels of glucose, total protein, total lipids and other blood chemistry. Endpoint is possible in receptor in the field.
Q ₂	2	2	2	Subchronic exposure (6 weeks)
Q ₃	1	1	1	NOAEL (125 ppm see discussion above)
U	2	2	2	Adequate numbers of test animals, 120 young chickens at each 5 dose levels. Reasonable design. Multiple doses assessed (0, 5, 25, 125, 250 ppm) and NOAEL established but no LOAEL and results were inconsistent.
M	0.5	0.5	0.5	Administered as HgCl ₂ in drinking water.
Total AF	2	4	6	$R * I * Q_1 * Q_2 * Q_3 * U = \text{Total AF}$
QCE (mg/kg-day)	12.1	12.1	12.1	QCE = quantified critical endpoint
TRV	6.05	3.03	2.02	Toxicity Reference Value = QCE/Total AF

R Value	TRV (mg/kg-day)	Justification	Appropriate Functional Group
1	6.05	Test organism is in the same order and trophic level as the functional group members	none
2	3.03	Test organism is in a different order and same trophic level from the functional group members	AV422, AV432, AV433, AV442
3	2.02	Test organism is in a different order and trophic level from the functional group members	AV121, AV122, AV132, AV142, AV143, AV210, AV210A, AV221, AV222, AV222A, AV232, AV233, AV241, AV242, AV310, AV322, AV333, AV342

Parkhurst, C.R., and P. Thaxton, 1973. *Toxicity of mercury to young chickens. I. Effect on growth and mortality*. Poultry Science 52:273-276.

* Wiseman, 1987

COPC: Mercury (organic) CAS 7439-97-6

Test Organisms: American black duck (Herbivore, Order-Anseriformes, *Anas rubripes*)
Exposure Medium: Oral in diet (mash)
Test Endpoint: Adverse effect level
Reference: Finley, M.T. and R.C. Stendell, 1978. "Survival and reproductive success of black ducks fed methylmercury", Environmental Pollution, 16:51-64.
QCE: 0.169 mg/kg-day (3 ppm Hg fed as methylmercury dicyandiamide)
 (3mg/kg food * 0.062 kg food/day)/(1.1 kg BW)

Adjustment Factors (AF)				Justification for adjustment factor
R	1	2	3	R = 1 is AF for same order and trophic level R = 2 is AF for different order and same trophic level R = 3 is AF for different order and trophic level
I	2	2	2	Variability appears average.
Q ₁	1	1	1	Clutch size, egg production, # of eggs incubated, hatchability and survival of ducklings.
Q ₂	1	1	1	Chronic exposure (28 weeks)
Q ₃	3	3	3	Adverse effect level (reduced reproduction success)
U	3	3	3	No NOAEL established and only 1 dose level and control. 13 pairs of 1 year old ducks in each group, juveniles also tested.
Total AF	18	36	54	$R * I * Q_1 * Q_2 * Q_3 * U = \text{Total AF}$
QCE (mg/kg-day)	0.169	0.169	0.169	QCE = quantified critical endpoint
TRV	0.0094	0.0047	0.0031	Toxicity Reference Value = QCE/Total AF

R Value	TRV (mg/kg-day)	Justification	Appropriate Functional Group
1	0.0094	Test organism is in the same order and trophic level as the functional group members	AV142, AV143
2	0.0047	Test organism is in a different order and same trophic level from the functional group members	AV121, AV122, AV132
3	0.0031	Test organism is in a different order and trophic level from the functional group members	AV210, AV210A, AV221, AV222, AV222A, AV232, AV233, AV241, AV242, AV310, AV322, AV333, AV342, AV422, AV432, AV433, AV442

BW is taken as the mean for females (1.1 kg) from the CRC Handbook of Avian Body Masses (Dunning, 1993)
 allometric equations from Nagy (1987) $FI = 0.648 BW^{0.651} = 0.062 \text{ kg/day}$

COPC:**Mercury (Organic) CAS 7439-97-6****Test Organisms:**Mallard Duck (Herbivore, Order-Anseriformes, *Anas platyrhynchos*)**Exposure Medium:**

Oral in diet

Test Endpoint:

LOAEL

Reference:

Heinz, G. H. 1979. Methyl mercury: reproductive and behavioral effects on three generations of mallard ducks. J. Wildl. Mgmt. 43:394-401.

QCE:

0.189 mg/kg-day 3 ppm methylmercury in diet. (3 ppm * 0.063 kg/kg bw/d)*

Adjustment Factors (AF)				Justification for adjustment factor
R	1	2	3	R = 1 is AF for same order and trophic level R = 2 is AF for different order and same trophic level R = 3 is AF for different order and trophic level
I	2	2	2	Only one dose level, however, this was a three generation study that showed significant effects from control.
Q ₁	1	1	1	Endpoints include reproductive endpoints (i.e. # of eggs and hatchlings). Ecologically relevant endpoint
Q ₂	1	1	1	Chronic
Q ₃	2	2	2	LOAEL - one dose only
U	2	2	2	3 generations (>1 yr. and during a critical life stage) and reproductive endpoints examined. However, only 1 dose considered.
Total AF	8	16	24	$R * I * Q_1 * Q_2 * Q_3 * U = \text{Total AF}$
QCE (mg/kg-day)	0.189	0.189	0.189	QCE = quantified critical endpoint
TRV	0.024	0.012	0.008	Toxicity Reference Value = QCE/Total AF

R Value	TRV (mg/kg-day)	Justification	Appropriate Functional Group
1	0.024	Test organism is in the same order and trophic level as the functional group members	AV142, AV143
2	0.012	Test organism is in a different order and same trophic level from the functional group members	AV121, AV122, AV132
3	0.008	Test organism is in a different order and trophic level from the functional group members	AV210, AV210A, AV221, AV222, AV222A, AV232, AV233, AV241, AV242, AV310, AV322, AV333, AV342, AV422, AV432, AV433, AV442

* EPA, 1993

COPC:**Mercury (Organic) CAS 7439-97-6****Test Organisms:**

Pheasants (Omnivore, Order-Galliformes)

Exposure Medium:

Gelatin capsule

Test Endpoint:

AEL

Reference:McEwen, L.C., et al., 1973. "Mercury-Wildlife Studies by the Denver Wildlife Research Center", In *Mercury in the Western Environment*, D.R. Buhler, Ed., Oregon State University, Corvallis, OR, p. 146-156.**QCE:**0.64 mg/kg-day 20 mg/kg Ceresan M^R (mercury fungicide) the 0.64 mg/kg-day was specified by article for a 1 kg bird

Adjustment Factors (AF)				Justification for adjustment factor
R	1	2	3	R = 1 is AF for same order and trophic level R = 2 is AF for different order and same trophic level R = 3 is AF for different order and trophic level
I	3	3	3	Not a large sample, three male and female pheasant pairs.
Q ₁	1	1	1	Endpoints included the # of eggs laid, fertile, hatched and alive chicks. Ecologically relevant endpoint.
Q ₂	2	2	2	Subchronic exposure (30 days)
Q ₃	3	3	3	Adverse effect level
U	3	3	3	Only 1 dosage and control in a pesticide formulation, small number of samples, and NOAEL not established. Author mentions that the capsule dosage is lower than what a wild bird would be estimated to ingest feeding on seeds.
Total AF	54	108	162	$R * I * Q_1 * Q_2 * Q_3 * U = \text{Total AF}$
QCE (mg/kg-day)	0.64	0.64	0.64	QCE = quantified critical endpoint
TRV	0.012	0.0059	0.0040	Toxicity Reference Value = QCE/Total AF

R Value	TRV (mg/kg-day)	Justification	Appropriate Functional Group
1	0.012	Test organism is in the same order and trophic level as the functional group members	none
2	0.0059	Test organism is in a different order and same trophic level from the functional group members	AV422, AV432, AV433, AV442
3	0.0040	Test organism is in a different order and trophic level from the functional group members	AV121, AV122, AV132, AV142, AV143, AV210, AV210A, AV221, AV222, AV222A, AV232, AV233, AV241, AV242, AV310, AV322, AV333, AV342

COPC: Mercury (Organic) CAS 7439-97-6

Test Organisms: Mouse (Omnivore, Order-Rodentia)

Exposure Medium: Oral in drinking water

Test Endpoint: NOAEL

Reference: Schroeder and Mitchner, 1975. "Life-term effects of mercury, methylmercury and nine other trace metals on mice" *J. Nutr.* 105:452.

QCE: 0.14 mg/kg-day Calculated, 1 ppm Hg as methylmercury acetate *

Adjustment Factors (AF)				Justification for adjustment factor
R	1	2	3	R = 1 is AF for same order and trophic level R = 2 is AF for different order and same trophic level R = 3 is AF for different order and trophic level
I	2	2	2	Groups of 36 to 54 mice of each sex were exposed. One control group. 5 ppm Hg as methylmercury acetate for 70 days and 1 ppm subsequently in the drinking water. 5 ppm was toxic but 1 ppm appears to have beneficial effects, with the mice that survived gaining weight and living longer than litter mates given 1 ppm from time of weaning.
Q ₁	1	1	1	Body weight, tumors, edema, blanching of incisor teeth, life-spans and longevities.
Q ₂	1	1	1	Lifetime exposure
Q ₃	1	1	1	NOAEL
U	2	2	2	Average study design with limited number of doses, and no reproductive endpoint or sensitive life stage examined. Random-bred white Swiss mice of Charles River CD strain. Both a NOAEL and LOAEL established.
M	0.5	0.5	0.5	Methylmercury acetate placed in drinking water.
Total AF	2	4	6	$R * I * Q_1 * Q_2 * Q_3 * U = \text{Total AF}$
QCE (mg/kg-day)	0.14	0.14	0.14	QCE = quantified critical endpoint
TRV	0.07	0.04	0.02	Toxicity Reference Value = QCE/Total AF

R Value	TRV (mg/kg-day)	Justification	Appropriate Functional Group
1	0.07	Test organism is in the same order and trophic level as the functional group members	none
2	0.04	Test organism is in a different order and same trophic level from the functional group members	M422, M422A
3	0.02	Test organism is in a different order and trophic level from the functional group members	M121, M122, M122A, M132, M210, M210A, M222, M322

[(1 mg Hg₂/L)(0.0051 L water/day**)/0.0373 kg BW]=0.14 mg/kg BW-day

**Ingestion rate of water calculated using allometric equation from the Wildlife Factors Handbook (EPA 1993)
WI=0.099BW^{0.9}

COPC:**Mercury (Inorganic) CAS 7439-97-6****Test Organisms:**

Mouse (Omnivore, Order-Rodentia)

Exposure Medium:

Oral in drinking water

Test Endpoint:

NOAEL

Reference:Schroeder and Mitchner, 1975. "Life-term effects of mercury, methylmercury and nine other trace metals on mice" *J. Nutr.* 105:452.**QCE:**

0.68 mg/kg-day Calculated 5 ppm Hg as mercuric chloride*.

Adjustment Factors (AF)				Justification for adjustment factor
R	1	2	3	R = 1 is AF for same order and trophic level R = 2 is AF for different order and same trophic level R = 3 is AF for different order and trophic level
I	2	2	2	Groups of 36 to 54 mice of each sex were exposed. One control group. At 5 ppm longevity tended to decrease in males and increase in females.
Q ₁	1	1	1	Body weight, tumors, edema, blanching of incisor teeth, life-spans and longevities
Q ₂	1	1	1	Lifetime exposure
Q ₃	1	1	1	NOAEL
U	2	2	2	No reproductive endpoint or sensitive life stage examined. Random-bred white Swiss mice of Charles River CD strain. 5 ppm Hg as mercuric chloride in the basal drinking water. Only one dose tested and no LOAEL established.
M	0.5	0.5	0.5	Placed in drinking water.
Total AF	2	4	6	$R * I * Q_1 * Q_2 * Q_3 * U = \text{Total AF}$
QCE (mg/kg-day)	0.68	0.68	0.68	QCE = quantified critical endpoint
TRV	0.34	0.17	0.11	Toxicity Reference Value = QCE/Total AF

R Value	TRV (mg/kg-day)	Justification	Appropriate Functional Group
1	0.34	Test organism is in the same order and trophic level as the functional group members	none
2	0.17	Test organism is in a different order and same trophic level from the functional group members	M422, M422A
3	0.11	Test organism is in a different order and trophic level from the functional group members	M121, M122, M122A, M132, M210, M210A, M222, M322

* [(5 mg Hg₂/L water)*(0.0051 L water/day**)/0.0373 kg BW]

Ingestion rate of water calculated using allometric equation from the Wildlife Factors Handbook (EPA 1993)

WI=0.099BW^{0.9}

COPC:	Mercury (Organic) CAS 7439-97-6		
Test Organisms:	Swine (Omnivore, Order-Artiodactyla)		
Exposure Medium:	Oral in diet (organic form methylmercuric chloride CH ₃ HgCL)		
Test Endpoint:	NOAEL		
Reference:	Chang C.W.J., R.M. Nakamura, and C.C. Brooks, 1977. "Effect of varied dietary levels and forms of mercury on swine" J. Anim. Sci. 45:279-285.		
QCE:	0.025 mg/kg-day	specified 0.5 ppm [(0.5 mg/kg)x(2.5kg/day)/50 kg	
BW*			

Adjustment Factors (AF)				Justification for adjustment factor
R	1	2	3	R = 1 is AF for same order and trophic level R = 2 is AF for different order and same trophic level R = 3 is AF for different order and trophic level
I	2	2	2	Thirty-two, three-way crossed pigs (Yorkshire, Duroc x Hampshire). Hg was mixed in feed at .5, 5.0, and 50.0 ppm. A control and group fed naturally contaminated feed was included. Feeding was controlled so that each pig received the same amount. Great variation existed between the level of Hg that accumulated in different tissue.
Q ₁	1	1	1	Endpoints were designed to measure the Hg accumulations in swine tissues (One gilt and one barrow from each group was removed for slaughter and examined at necropsy for fatty livers, lesions, enlarged lymph nodes, etc.), as well as determine teratogenic or behavioral effects on piglets born to exposure animals.
Q ₂	2	2	2	Subchronic exposure (exposure through breeding and birthing, however estimated at less than 50% of the total life span of a pig)
Q ₃	1	1	1	NOAEL
U	1	1	1	Good design, reproductive endpoint examined. LOAEL was established, however, different between NOAEL and LOAEL levels is great.
Total AF	4	8	12	$R * I * Q_1 * Q_2 * Q_3 * U = \text{Total AF}$
QCE (mg/kg-day)	0.025	0.025	0.025	QCE = quantified critical endpoint
TRV	0.0063	0.0031	0.0021	Toxicity Reference Value = QCE/Total AF

R Value	TRV (mg/kg-day)	Justification	Appropriate Functional Group
1	0.0063	Test organism is in the same order and trophic level as the functional group members	None
2	0.0031	Test organism is in a different order and same trophic level from the functional group members	M422, M422A
3	0.0021	Test organism is in a different order and trophic level from the functional group members	M121, M122, M122A, M123, M210, M210A, M222, M322

*Ingestion rate from allometric equation , BW from study.

COPC: Mercury (Inorganic) CAS 7439-97-6

Test Organisms: Swine (Omnivore, Order-Artiodactyla)

Exposure Medium: Oral in diet (as mercuric chloride-HgCl₂)

Test Endpoint: NOAEL

Reference: Chang C.W.J., R.M. Nakamura, and C.C. Brooks, 1977. "Effect of varied dietary levels and forms of mercury on swine" J. Anim. Sci. 45:279-285.

QCE: 0.25 mg/kg-day (HgCl₂) specified 5 ppm (5 mg/kg)x(2.5kg/day)/50 kg BW*

Adjustment Factors (AF)				Justification for adjustment factor
R	1	2	3	R = 1 is AF for same order and trophic level R = 2 is AF for different order and same trophic level R = 3 is AF for different order and trophic level
I	2	2	2	Thirty-two, three-way crossed pigs (Yorkshire, Duroc x Hampshire). Hg was mixed in feed at .5, 5.0, and 50.0 ppm. A control and group fed naturally contaminated feed was included. Feeding was controlled so that each pig received the same amount. Great variation existed between the level of Hg that accumulated in different tissue.
Q ₁	1	1	1	Endpoints were designed to measure the Hg accumulations in swine tissues (One gilt and one barrow from each group was removed for slaughter and examined at necropsy for fatty livers, lesions, enlarged lymph nodes, etc.), as well as determine teratogenic or behavioral effects on piglets born to exposure animals.
Q ₂	2	2	2	Subchronic exposure (exposure through breeding and birthing, however estimated at less than 50% of the total life span of a pig)
Q ₃	1	1	1	NOAEL
U	1	1	1	Good design, reproductive endpoint examined, however no LOAEL established.
Total AF	4	8	12	$R * I * Q_1 * Q_2 * Q_3 * U = \text{Total AF}$
QCE (mg/kg-day)	0.25	0.25	0.25	QCE = quantified critical endpoint
TRV	0.063	0.031	0.021	Toxicity Reference Value = QCE/Total AF

R Value	TRV (mg/kg-day)	Justification	Appropriate Functional Group
1	0.063	Test organism is in the same order and trophic level as the functional group members	None
2	0.031	Test organism is in a different order and same trophic level from the functional group members	M422, M422A
3	0.021	Test organism is in a different order and trophic level from the functional group members	M121, M122, M122A, M123, M210, M210A, M222, M322

*Ingestion rate from allometric equation, BW from study

COPC: Mercury (Organic) CAS 7439-97-6

Test Organisms: Cat (Carnivore, Order-Carnivora)

Exposure Medium: Diet

Test Endpoint: NOAEL

Reference: Charbornneau. S.M., et al., 1976. *Chronic Toxicity of Methylmercury in the Adult Cat*, Interim Report, Toxicology, 5(1976):337-349.

QCE: 0.02 mg/kg-day Specified -either in naturally contaminated fish (methylmercury) or added to diet as methylmercuric chloride.

Adjustment Factors (AF)				Justification for adjustment factor
R	1	2	3	R = 1 is AF for same order and trophic level R = 2 is AF for different order and same trophic level R = 3 is AF for different order and trophic level
I	2	2	2	Each test group consisted of 8 random-bred domestic cats, 4 males and 4 females. Not rigorously examined, but no large variations within groups were evident
Q ₁	1	1	1	Food consumption, body weight, blood and urine changes and neurological status were examined. Ecologically relevant endpoint
Q ₂	1	1	1	Chronic duration (2 years)
Q ₃	1	1	1	NOAEL
U	2	2	2	Doses of 3, 8.4, 20, 46, 74 or 176 µg Hg/kg/day both in fish and as corn oil supplement. Older study, but thoroughly performed. Dose-response well-characterized for neurological effects, but reproductive effects not considered.
Total AF	4	8	12	$R * I * Q_1 * Q_2 * Q_3 * U = \text{Total AF}$
QCE (mg/kg-day)	.02	.02	.02	QCE = quantified critical endpoint
TRV	0.005	0.003	0.002	Toxicity Reference Value = QCE/Total AF

R Value	TRV (mg/kg-day)	Justification	Appropriate Functional Group
1	.005	Test organism is in the same order and trophic level as the functional group members	M322
2	.003	Test organism is in a different order and same trophic level from the functional group members	M422A
3	.002	Test organism is in a different order and trophic level from the functional group members	M121, M122, M122A, M123, M132, M210, M210A, M222, M422

COPC:**Mercury (Organic) CAS 7439-97-6****Test Organisms:**

Mule Deer (Herbivore, Order-Artiodactyla)

Exposure Medium:

Single dose

Test Endpoint:FEL (LD₅₀)**Reference:**Eisler, R., 1987, *Mercury Hazards to Fish, Wildlife, and Invertebrates: A Synoptic Review*, U.S. Fish and Wildlife Service Biological Report, 85(1.10).**QCE:**

18 mg/kg-day

Adjustment Factors (AF)				Justification for adjustment factor
R	1	2	3	R = 1 is AF for same order and trophic level R = 2 is AF for different order and same trophic level R = 3 is AF for different order and trophic level
I	3	3	3	From secondary source, no other information
Q ₁	1	1	1	Ecologically relevant endpoint (lethality)
Q ₂	3	3	3	Acute study
Q ₃	3	3	3	LD ₅₀
U	3	3	3	Secondary source, little supporting information
Total AF	81	162	243	$R * I * Q_1 * Q_2 * Q_3 * U = \text{Total AF}$
QCE (mg/kg-day)	18	18	18	QCE = quantified critical endpoint
TRV	0.22	0.11	0.07	Toxicity Reference Value = QCE/Total AF

R Value	TRV (mg/kg-day)	Justification	Appropriate Functional Group
1	0.22	Test organism is in the same order and trophic level as the functional group members	None
2	0.11	Test organism is in a different order and same trophic level from the functional group members	M121, M122, M122A, M123, M132
3	0.07	Test organism is in a different order and trophic level from the functional group members	M210, M210A, M222, M322, M422, M422A

COPC:**Mercury (Organic) CAS 7439-97-6****Test Organisms:**

Mink (Carnivore, Order-Carnivora)

Exposure Medium:

Oral in diet as methyl mercury chloride

Test Endpoint:

NOAEL

Reference:

Wobeser, G., N.O. Nielson, and B. Schiefer. 1976. "Mercury and mink II. Experimental methyl mercury intoxication." Can. J. Comp. Med. 34-45.

QCE:

0.15 mg/kg-day (1.1 mg Hg/kg food * 0.137 kg food /day)/(1 kg BW)

Adjustment Factors (AF)				Justification for adjustment factor
R	1	2	3	R = 1 is AF for same order and trophic level R = 2 is AF for different order and same trophic level R = 3 is AF for different order and trophic level
I	2	2	2	Five adult female mink per treatment group were sampled at 1.1, 1.8, 4.8, 8.3 and 15 ppm Hg in diet. Study for 93 days and not during a critical life stage.
Q ₁	1	1	1	Mortality, weight loss and ataxia. Ecologically relevant endpoint
Q ₂	1	1	1	Chronic study, 93 days
Q ₃	1	1	1	NOAEL
U	2	2	2	Mercury doses of 1.8 ppm or greater produced significant adverse effects as a LOAEL. Mercury levels in tissue were evident at 1.1 ppm however, no significant effects observed. However, endpoint not based on reproduction.
M	1	1	1	Appropriate exposure medium for INEL
Total AF	4	8	12	$R * I * Q_1 * Q_2 * Q_3 * U = \text{Total AF}$
QCE (mg/kg-day)	0.15	0.15	0.15	QCE = quantified critical endpoint
TRV	0.038	0.019	0.013	Toxicity Reference Value = QCE/Total AF

R Value	TRV (mg/kg-day)	Justification	Appropriate Functional Group
1	0.038	Test organism is in the same order and trophic level as the functional group members	none
2	0.019	Test organism is in a different order and same trophic level from the functional group members	M121, M122, M122A, M123, M132
3	0.013	Test organism is in a different order and trophic level from the functional group members	M210, M210A, M222, M322, M422, M422A

COPC:**Mercury (Organic) CAS 7439-97-6****Test Organisms:**

Pheasant (Omnivore, Order-Galliformes)

Exposure Medium:

Diet

Test Endpoint:

LOAEL

Reference:

Fimreite, N., 1979, *Accumulation and Effects of Mercury on Birds*, Chapter 22 in *The biogeochemistry of Mercury in the Environment*, J.O. Nriagu, (ed.), Elsevier/North Holland Biomedical Press, New York.

QCE:

0.18 mg/kg-day Specified

Adjustment Factors (AF)				Justification for adjustment factor
R	1	2	3	R = 1 is AF for same order and trophic level R = 2 is AF for different order and same trophic level R = 3 is AF for different order and trophic level
I	3	3	3	From secondary source, no other information, cited in EPA, 1993, Wildlife Exposure Factors Handbook
Q ₁	1	1	1	Ecologically relevant endpoint (egg production, shell thickness, hatchability)
Q ₂	1	1	1	Chronic duration (12 weeks)
Q ₃	2	2	2	LOAEL endpoint
U	2	2	2	Old study, secondary source, no NOAEL identified
Total AF	12	24	36	$R * I * Q_1 * Q_2 * Q_3 * U = \text{Total AF}$
QCE (mg/kg-day)	0.18	0.18	0.18	QCE = quantified critical endpoint
TRV	0.015	0.008	0.005	Toxicity Reference Value = QCE/Total AF

R Value	TRV (mg/kg-day)	Justification	Appropriate Functional Group
1	0.015	Test organism is in the same order and trophic level as the functional group members	none
2	0.008	Test organism is in a different order and same trophic level from the functional group members	AV422, AV432, AV433, AV442
3	0.005	Test organism is in a different order and trophic level from the functional group members	AV121, AV122, AV132, AV142, AV143, AV210, AV210A, AV221, AV222, AV222A, AV232, AV233, AV241, AV242, AV310, AV322, AV333, AV342

COPC: Mercury (Organic) CAS 7439-97-6

Test Organisms: Rat (Omnivore, Order-Rodentia)

Exposure Medium: Oral (methylmercuric chloride in diet)

Test Endpoint: NOAEL

Reference: Khara and Tabacova, 1973, *Effects of Methylmercuric Chloride on the Progeny of Mice and Rats Treated Before or During Gestation*, Food and Cosmetic Toxicology, 11:245-254.

QCE: 0.05 mg/kg-day (Specified)

Adjustment Factors (AF)				Justification for adjustment factor
R	1	2	3	R = 1 is AF for same order and trophic level R = 2 is AF for different order and same trophic level R = 3 is AF for different order and trophic level
I	2	2	2	No prenatal effects were seen at 0.25 mg/kg-day however, an increased incidence of eye defects was seen. The study suggests that mercury was a contributory factor, in some unexplained way. This paper provides documentation of studies providing similar results.
Q ₁	1	1	1	Reproductive success measured, by #of pregnant mice, # of young per litter, weight of young, and postnatal survival. Ecologically relevant endpoint.
Q ₂	1	1	1	Chronic duration
Q ₃	1	1	1	NOAEL
U	1	1	1	Immature females of the Wistar strain were randomized into 5 groups each consisting of 35 rats. Doses included 0, 0.002, 0.01, 0.05, or 0.25 mg Hg/kg/day as CH ₃ HgCl. The exposure was continued for sub-groups up to 192 days. Highest dose level was NOAEL for sensitive and relevant endpoint and LOAEL was not established.
Total AF	2	4	6	$R * I * Q_1 * Q_2 * Q_3 * U = \text{Total AF}$
QCE (mg/kg-day)	0.05	0.05	0.05	QCE = quantified critical endpoint
TRV	0.03	0.01	0.008	Toxicity Reference Value = QCE/Total AF

R Value	TRV (mg/kg-day)	Justification	Appropriate Functional Group
1	0.03	Test organism is in the same order and trophic level as the functional group members	none
2	0.01	Test organism is in a different order and same trophic level from the functional group members	M422, M422A
3	0.008	Test organism is in a different order and trophic level from the functional group members	M121, M122, M122A, M132, M210, M210A, M222, M322

COPC: Mercury (Organic) CAS 7439-97-6

Test Organisms: Rat (Omnivore, Order-Rodentia)

Exposure Medium: Oral in diet

Test Endpoint: NOAEL

Reference: Verschuuren, H.G., et al., 1976, *Toxicity of methyl mercury chloride in rats. II. Reproduction study*. Toxicol. 6:97-106.

QCE: 0.025 mg/kg-day Calculated

Adjustment Factors (AF)				Justification for adjustment factor
R	1	2	3	R = 1 is AF for same order and trophic level R = 2 is AF for different order and same trophic level R = 3 is AF for different order and trophic level
I	1	1	1	3 generation (> 1 yr. and during a critical life stage – chronic)
Q ₁	1	1	1	Ecologically relevant endpoint (reproduction)
Q ₂	1	1	1	Chronic duration
Q ₃	1	1	1	NOAEL
U	1	1	1	
Total AF	1	2	3	$R * I * Q_1 * Q_2 * Q_3 * U = \text{Total AF}$
QCE (mg/kg-day)	0.025	0.025	0.025	QCE = quantified critical endpoint
TRV	0.025	0.013	0.0083	Toxicity Reference Value = QCE/Total AF

R Value	TRV (mg/kg-day)	Justification	Appropriate Functional Group
1	0.025	Test organism is in the same order and trophic level as the functional group members	none
2	0.013	Test organism is in a different order and same trophic level from the functional group members	M422, M422A
3	0.0083	Test organism is in a different order and trophic level from the functional group members	M121, M122, M122A, M132, M210, M210A, M222, M322

COPC: Nickel CAS 7440-02-0

Test Organisms: Chicken (Omnivore, Order-Galliformes)

Exposure Medium: Diet

Test Endpoint: NOAEL

Reference: Weber, C.W., and Reid, B.L., 1968, *Nickel toxicity in growing chicks*, J. Nutr. 95:612-616.

QCE: 37 mg/kg-day 500 ppm in diet converted to a dose using an estimated ingestion rate* of 0.037 kg/day and a body weight of 500 g from the study.

Adjustment Factors (AF)				Justification for adjustment factor
R	1	2	3	R = 1 is AF for same order and trophic level R = 2 is AF for different order and same trophic level R = 3 is AF for different order and trophic level
I	1	1	1	Subchronic toxicity studies with adequate numbers of animals
Q ₁	1	1	1	Production parameters (growth)
Q ₂	2	2	2	Subchronic study
Q ₃	1	1	1	NOAEL endpoint
U	3	3	3	Older study, reproductive endpoints not evaluated
Total AF	6	12	18	$R * I * Q_1 * Q_2 * Q_3 * U = \text{Total AF}$
QCE (mg/kg-day)	37	37	37	QCE = quantified critical endpoint
TRV	6.2	3.1	2.1	Toxicity Reference Value = QCE/Total AF

R Value	TRV (mg/kg-day)	Justification	Appropriate Functional Group
1	6.2	Test organism is in the same order and trophic level as the functional group members	none
2	3.1	Test organism is in a different order and same trophic level from the functional group members	AV422, AV432, AV433, AV442
3	2.1	Test organism is in a different order and trophic level from the functional group members	AV121, AV122, AV132, AV142, AV143, AV210, AV210A, AV221, AV222, AV222A, AV232, AV233, AV241, AV242, AV310, AV322, AV333, AV342

*Estimated as $0.0582 \text{ Wt}^{0.651}$ (kg) as cited in EPA, 1993. Wildlife Exposure Factors Handbook.

COPC: Nickel CAS 7440-02-0
(nickel carbonate)

Test Organisms: Bovine (Herbivore, Order-Artiodactyla)

Exposure Medium: Diet

Test Endpoint: NOAEL

Reference: O'Dell et al., 1970a, 'Effect of Nickel Supplementation on the Production and composition of Milk, *J. Dairy Science*. National Academy of Sciences, 1980, *Mineral Tolerance of Domestic Animals*, Washington, DC.

QCE: 4.1 mg/kg-day 1835mg/day/450 kg BW

Adjustment Factors (AF)				Justification for adjustment factor
R	1	2	3	R = 1 is AF for same order and trophic level R = 2 is AF for different order and same trophic level R = 3 is AF for different order and trophic level
I	3	3	3	Secondary source
Q ₁	1	1	1	Growth and food intake
Q ₂	2	2	2	Subchronic study
Q ₃	1	1	1	NOAEL endpoint
U	3	3	3	Limited information or supporting studies.
Total AF	18	36	54	$R * I * Q_1 * Q_2 * Q_3 * U = \text{Total AF}$
QCE (mg/kg-day)	4.1	4.1	4.1	QCE = quantified critical endpoint
TRV	0.23	0.11	0.08	Toxicity Reference Value = QCE/Total AF

R Value	TRV (mg/kg-day)	Justification	Appropriate Functional Group
1	0.23	Test organism is in the same order and trophic level as the functional group members	none
2	0.11	Test organism is in a different order and same trophic level from the functional group members	M121, M122, M122A, M123, M132
3	0.08	Test organism is in a different order and trophic level from the functional group members	M210, M210A, M222, M322, M422, M422A

*BW an estimate until get actual article

**Other O'Dell articles may be more helpful, check the NAS book.

COPC: Nickel CAS 7440-02-0

Test Organisms: Mallard Duck

Exposure Medium: Oral in diet

Test Endpoint: NOAEL

Reference: Cain, B.W. and E.A. Pafford, 1981, "Effects of Dietary Nickel on Survival and Growth of Mallard Duckling", *Arch. Environm. Contam. Toxicol.* 10, 737-745.

QCE: 200 ppm

Adjustment Factors (AF)				Justification for adjustment factor
R	1	2	3	R = 1 is AF for same order and trophic level R = 2 is AF for different order and same trophic level R = 3 is AF for different order and trophic level
I	2	2	2	36 ducklings divided into 6 cages with 6 birds per cage (3 male 3 female). 12 birds were given a dose of either 200, 800, or 1200 ppm.
Q ₁	1	1	1	Development endpoints measured (body weight, bill length, humerus, heart, liver, gizzard, kidneys).
Q ₂	1	1	1	Chronic study (60-90 days)
Q ₃	1	1	1	NOAEL
U	1	1	1	Good supporting references.
Total AF	2	4	6	$R * I * Q_1 * Q_2 * Q_3 * U = \text{Total AF}$
QCE (mg/kg-day)	200	200	200	QCE = quantified critical endpoint
TRV	100	50	33	Toxicity Reference Value = QCE/Total AF

R Value	TRV (mg/kg-day)	Justification	Appropriate Functional Group
1	100	Test organism is in the same order and trophic level as the functional group members	AV142, AV143
2	50	Test organism is in a different order and same trophic level from the functional group members	AV121, AV122, AV132
3	33	Test organism is in a different order and trophic level from the functional group members	AV210, AV210A, AV221, AV222, AV222A, AV232, AV233, AV241, AV242, AV310, AV322, AV333, AV342, AV422, AV432, AV433, AV442

COPC: Nickel CAS 7440-02-0

Test Organisms: Dog (Omnivore, Order-Carnivora)

Exposure Medium: Diet

Test Endpoint: NOAEL

Reference: Ambrose, A.M. et al. 1976, *Long-Term Toxicologic Assessment of Nickel in Rats and Dogs*, *J. Food Sci. Technol.* 13:181-187.

QCE: 25 mg/kg-day

Adjustment Factors (AF)				Justification for adjustment factor
R	1	2	3	R = 1 is AF for same order and trophic level R = 2 is AF for different order and same trophic level R = 3 is AF for different order and trophic level
I	1	1	1	Chronic toxicity study with adequate numbers of animals
Q ₁	1	1	1	Body weight gain
Q ₂	1	1	1	Chronic study
Q ₃	1	1	1	NOAEL endpoint
U	2	2	2	Limited information or supporting studies.
Total AF	2	4	6	$R * I * Q_1 * Q_2 * Q_3 * U = \text{Total AF}$
QCE (mg/kg-day)	25	25	25	QCE = quantified critical endpoint
TRV	13	6.3	4.2	Toxicity Reference Value = QCE/Total AF

R Value	TRV (mg/kg-day)	Justification	Appropriate Functional Group
1	13	Test organism is in the same order and trophic level as the functional group members	M422A
2	6.3	Test organism is in a different order and same trophic level from the functional group members	M422
3	4.2	Test organism is in a different order and trophic level from the functional group members	M121, M122, M122A, M123, M210, M210A, M222, M322

COPC: Nickel CAS 7440-02-0

Test Organisms: Mallard (Herbivore, Order-Anseriformes)

Exposure Medium: Diet

Test Endpoint: NOAEL

Reference: Eastin, W.C., Jr. and O'Shea, T.J., 1981, *Effects of Dietary Nickel on Mallards*, J. Toxicol. Environ. Health 7(6):883-892.
White, D.H., and M.P. Dieter, 1978, *Effects of Dietary Vanadium in Mallard Ducks*, Journal of Toxicol. and Environ. Health, 4:43-50.

QCE: 140 mg/kg-day (800mg/kg food)*(0.205mg/day*)/1.17 kg BW **

Adjustment Factors (AF)				Justification for adjustment factor
R	1	2	3	R = 1 is AF for same order and trophic level R = 2 is AF for different order and same trophic level R = 3 is AF for different order and trophic level
I	2	2	2	Subchronic toxicity study; variability not addressed
Q ₁	1	1	1	Egg production, hatchability, duckling survival; hematological parameters
Q ₂	2	2	2	Subchronic study
Q ₃	1	1	1	NOAEL endpoint
U	2	2	2	Reproductive endpoints evaluated, no LOAEL identified.
Total AF	8	16	24	$R * I * Q_1 * Q_2 * Q_3 * U = \text{Total AF}$
QCE (mg/kg-day)	140	140	140	QCE = quantified critical endpoint
TRV	17.5	8.75	5.83	Toxicity Reference Value = QCE/Total AF

R Value	TRV (mg/kg-day)	Justification	Appropriate Functional Group
1	17.5	Test organism is in the same order and trophic level as the functional group members	AV142, AV143
2	8.75	Test organism is in a different order and same trophic level from the functional group members	AV121, AV122, AV132
3	5.83	Test organism is in a different order and trophic level from the functional group members	AV210, AV210A, AV221, AV222, AV222A, AV232, AV233, AV241, AV242, AV310, AV322, AV333, AV342, AV422, AV432, AV433, AV442

*Birds on 800ppm diet ate 15% more food than the 178g/day of the controls = 205g

**Body weight is indicated in the 1978 White and Dieter study.

COPC:

Nickel CAS 7440-02-0

Test Organisms:

Rat (Omnivore, Order-Rodentia)

Exposure Medium:

Diet

Test Endpoint:

NOAEL

Reference:Ambrose, A.M., et al., 1976 *Long-Term Toxicologic Assessment of Nickel in Rats and Dogs*, *J. Food Sci. Technol.* 13:181-187.ABC (American Biogenics Corp.), 1986, *Ninety-Day Gavage Study in Albino Rats Using Nickel*, Draft Final Report submitted to Research Triangle Institute, P.O. Box 12194, Research Triangle Park, NC 27709.RTI (Research Triangle Institute), 1987, *Two Generation Reproduction and Fertility Study of Nickel Chloride Administered to CD Rats in Drinking Water: Fertility and Reproductive Performance of the Po Generation (Part II of III) and F1 Generation (Part III of III)*, Final study report, Report submitted to Office of Solid Waste Management, U.S. EPA, Washington, DC.**QCE:**

5 mg/kg-day (Specified)

Adjustment Factors (AF)				Justification for adjustment factor
R	1	2	3	R = 1 is AF for same order and trophic level R = 2 is AF for different order and same trophic level R = 3 is AF for different order and trophic level
I	1	1	1	Chronic toxicity study with adequate numbers of animals.
Q ₁	1	1	1	Body weight gain
Q ₂	1	1	1	Chronic study
Q ₃	1	1	1	NOAEL endpoint
U	2	2	2	Low survival in controls; however, another study by ABC, 1986 supports the 5 mg/kg/day NOAEL. A NOAEL for reproductive effects in a study by RTI (1987) was higher than the Ambrose study.
Total AF	2	4	6	$R * I * Q_1 * Q_2 * Q_3 * U = \text{Total AF}$
QCE (mg/kg-day)	5	5	5	QCE = quantified critical endpoint
TRV	2.5	1.3	0.83	Toxicity Reference Value = QCE/Total AF

R Value	TRV (mg/kg-day)	Justification	Appropriate Functional Group
1	2.5	Test organism is in the same order and trophic level as the functional group members	none
2	1.3	Test organism is in a different order and same trophic level from the functional group members	M422, M422A
3	0.83	Test organism is in a different order and trophic level from the functional group members	M121, M122, M122A, M132, M210, M210A, M222, M322

COPC: Nitrate CAS 1594-56-5

Test Organisms: Rabbits (Herbivores, Order-Lagomorpha)
Exposure Medium: Oral in diet
Test Endpoint: Adverse effect level - reproductive (reduced fertility)
Reference: Southwest Vet., 24:246, 1974; HSDB.
QCE: 3994 mg/kg-day (from potassium nitrate)

Adjustment Factors (AF)				Justification for adjustment factor
R	1	2	3	R = 1 is AF for same order and trophic level R = 2 is AF for different order and same trophic level R = 3 is AF for different order and trophic level
I	2	2	2	Secondary source so information on number and sexes of animals tested unknown. Pregnant females tested.
Q ₁	1	1	1	Ecologically relevant endpoint (reproduction)
Q ₂	2	2	2	Subchronic exposure (days 23 through 27 of pregnancy)
Q ₃	3	3	3	Adverse effect level
U	2	2	2	Limited information, no reproductive endpoints and sensitive life stage examined. No NOAEL established.
Total AF	24	48	72	$R * I * Q_1 * Q_2 * Q_3 * U = \text{Total AF}$
QCE (mg/kg-day)	3994	3994	3994	QCE = quantified critical endpoint
TRV	166.4	83.21	55.47	Toxicity Reference Value = QCE/Total AF

R Value	TRV (mg/kg-day)	Justification	Appropriate Functional Group
1	166.4	Test organism is in the same order and trophic level as the functional group members	none
2	83.21	Test organism is in a different order and same trophic level from the functional group members	M121, M122, M122A, M123, M132
3	55.47	Test organism is in a different order and trophic level from the functional group members	M210, M210A, M222, M322, M422, M422A

COPC:

Nitrate CAS 1594-56-5

Test Organisms:

Juvenile turkeys (Omnivore, Order-Galliformes)

Exposure Medium:

Oral in drinking water

Test Endpoint:

FEL

Reference:

Humphreys Vet. Toxicol., 3rd Ed., 1988: HSDB.

QCE:

481 mg/kg-day (from sodium nitrate)

Adjustment Factors (AF)				Justification for adjustment factor
R	1	2	3	R = 1 is AF for same order and trophic level R = 2 is AF for different order and same trophic level R = 3 is AF for different order and trophic level
I	2	2	2	Secondary source so information on number and sexes of animals tested unknown.
Q ₁	1	1	1	Ecologically relevant endpoint (lethality)
Q ₂	3	3	3	Duration of exposure unknown
Q ₃	3	3	3	FEL
U	2	2	2	Limited information and reproductive endpoints and sensitive life stages examined. No NOAEL established.
M	0.5	0.5	0.5	Placed in drinking water.
Total AF	18	36	54	$R * I * Q_1 * Q_2 * Q_3 * U = \text{Total AF}$
QCE (mg/kg-day)	481	481	481	QCE = quantified critical endpoint
TRV	26.7	13.4	8.9	Toxicity Reference Value = QCE/Total AF

R Value	TRV (mg/kg-day)	Justification	Appropriate Functional Group
1	26.7	Test organism is in the same order and trophic level as the functional group members	none
2	13.4	Test organism is in a different order and same trophic level from the functional group members	AV422, AV432, AV433, AV442
3	8.9	Test organism is in a different order and trophic level from the functional group members	AV121, AV122, AV132, AV142, AV143, AV210, AV210A, AV221, AV222, AV222A, AV232, AV233, AV241, AV242, AV310, AV322, AV333, AV342

COPC:**PCBs (Aroclor 1254) CAS 11097-69-1****Test Organisms:**Pheasant (*Phasianus colchicus*, Omnivore, Order-Galliformes)**Exposure Medium:**

Gelatin capsule with corn oil

Test Endpoint:

LOAEL

Reference:Dahlgren, R.B., R.L. Linder, and C.W. Carlson, 1972, *Polychlorinated Biphenyls: Their Effects on Pened Pheasants*, *Environmental Health Perspectives*, 1:89-101.**QCE:**

1.8 mg/kg-day 12.5 mg/wk for 16 weeks; assumed BW of 1 kg (Wildlife Exposure Factors Handbook (EPA, 1993))

Adjustment Factors (AF)				Justification for adjustment factor
R	1	2	3	R = 1 is AF for same order and trophic level R = 2 is AF for different order and same trophic level R = 3 is AF for different order and trophic level
I	2	2	2	Results presented in this paper are from 1970 and 1971 study. The 1970 part was reported in Dahlgren and Linder (1971). Two groups of 5 cocks each were given weekly gelatin capsule with control or 25 mg PCB. Hens (30 in 1970 and 34 in 1971) were given weekly a gelatin capsule with either 12.5 or 50 mg PCB. Some differences seen from 1 st to 2 nd year.
Q ₁	1	1	1	# eggs laid, egg fertility, hatchability, eggshell thickness, and chick behavior, weight and survival. Ecologically relevant endpoint
Q ₂	1	1	1	Chronic duration (16 weeks)
Q ₃	2	2	2	LOAEL endpoint
U	2	2	2	Very thorough study that looks at ecologically relevant endpoints (relatively insensitive neuro. endpoints). Bolus dosing method might result in less absorption than daily exposure and exposure subchronic to adults only; however, effects noted were slight and variable, and dose-response varied from one year to the next, however, lowest dose (at which response was seen) was used. No NOAEL established.
Total AF	8	16	24	$R * I * Q_1 * Q_2 * Q_3 * U = \text{Total AF}$
QCE (mg/kg-day)	1.8	1.8	1.8	QCE = quantified critical endpoint
TRV	0.23	0.11	0.08	Toxicity Reference Value = QCE/Total AF

R Value	TRV (mg/kg-day)	Justification	Appropriate Functional Group
1	0.23	Test organism is in the same order and trophic level as the functional group members	none
2	0.11	Test organism is in a different order and same trophic level from the functional group members	AV422, AV432, AV433, AV442
3	0.08	Test organism is in a different order and trophic level from the functional group members	AV121, AV122, AV132, AV142, AV143, AV210, AV210A, AV221, AV222, AV222A, AV232, AV233, AV241, AV242, AV310, AV322, AV333, AV342

Dahlgren, R.B., and R.L. Linder, 1971, *Effects of Polychlorinated Biphenyls on Pheasant Reproduction, Behavior, and Survival*, *Journal of Wildlife Management*, 35(2):315-319

COPC:**PCBs (Aroclor 1254) CAS 11097-69-1****Test Organisms:**

Rat (Omnivore, Order-Rodentia)

Exposure Medium:

Diet in chow

Test Endpoint:

NOAEL

Reference:Linder, R.E., T.B. Gaines, and R.D. Kimbrough, 1974, *The Effect of Polychlorinated Biphenyls on Rat Reproduction*, Food and Cosmetic Toxicology, 12:63-77.**QCE:**

0.32 mg/kg-day (Specified)

Adjustment Factors (AF)				Justification for adjustment factor
R	1	2	3	R = 1 is AF for same order and trophic level R = 2 is AF for different order and same trophic level R = 3 is AF for different order and trophic level
I	1	1	1	Well-designed long-term study
Q ₁	1	1	1	Liver weights, # of litter, litter size, and survival of young. Ecologically relevant endpoints
Q ₂	1	1	1	Chronic study
Q ₃	1	1	1	NOAEL endpoint
U	1	1	1	Thorough, well-designed and analyzed, relevant study. Multiple doses examined at different generations.
Total AF	1	2	3	$R * I * Q_1 * Q_2 * Q_3 * U = \text{Total AF}$
QCE (mg/kg-day)	0.32	0.32	0.32	QCE = quantified critical endpoint
TRV	0.32	0.16	0.11	Toxicity Reference Value = QCE/Total AF

R Value	TRV (mg/kg-day)	Justification	Appropriate Functional Group
1	0.32	Test organism is in the same order and trophic level as the functional group members	none
2	0.16	Test organism is in a different order and same trophic level from the functional group members	M422, M422A
3	0.11	Test organism is in a different order and trophic level from the functional group members	M121, M122, M122A, M132, M210, M210A, M222, M322

COPC:**PCBs (Aroclor 1260) CAS 11096-82-5****Test Organisms:**

Rat (Omnivore, Order-Rodentia)

Exposure Medium:

Diet in chow

Test Endpoint:

NOAEL

Reference:Linder, R.E., T.B. Gaines, and R.D. Kimbrough, 1974, *The Effect of Polychlorinated Biphenyls on Rat Reproduction*, Food and Cosmetic Toxicology, 12:63-77.**QCE:**

7.4 mg/kg-day (Specified)

Adjustment Factors (AF)				Justification for adjustment factor
R	1	2	3	R = 1 is AF for same order and trophic level R = 2 is AF for different order and same trophic level R = 3 is AF for different order and trophic level
I	1	1	1	Well-designed long-term study showed relatively low variability in response (10 males and 20 females)
Q ₁	1	1	1	Ecologically relevant endpoint: viability counts of offspring, body weights, livers, weights of spleen, heart, lungs, brain, kidneys, testes.
Q ₂	1	1	1	Chronic duration
Q ₃	1	1	1	NOAEL endpoint
U	1	1	1	Thorough, well-designed and analyzed, relevant study, testing different doses (0,5,20,100ppm). Started on diets at 3-4 weeks of age, doses continued through mating, gestation, and lactation. No LOAEL established.
M	1	1	1	Not applicable
Total AF	1	2	3	$R * I * Q_1 * Q_2 * Q_3 * U = \text{Total AF}$
QCE (mg/kg-day)	7.4	7.4	7.4	QCE = quantified critical endpoint
TRV	7.4	3.7	2.5	Toxicity Reference Value = QCE/Total AF

R Value	TRV (mg/kg-day)	Justification	Appropriate Functional Group
1	7.4	Test organism is in the same order and trophic level as the functional group members	none
2	3.7	Test organism is in a different order and same trophic level from the functional group members	M422, M422A
3	2.5	Test organism is in a different order and trophic level from the functional group members	M121, M122, M122A, M132, M210, M210A, M222, M322

COPC:**PCBs (Aroclor 1254) CAS 11097-69-1****Test Organisms:** Mink (Carnivore, Order-Carnivora)**Exposure Medium:** Diet**Test Endpoint:** NOAEL**Reference:** Aulerich, R.J. and R.K. Ringer. 1977. Current status of PCB toxicity, including reproduction in mink. Arch. Environ. Contam. Toxicol. 6:279.**QCE:** 0.137 mg/kg-day 1 ppm in diet, 0.137 kg food/day (Bleavins and Aulerich 1981), and 1 kg BW (EPA, 1993)

Adjustment Factors (AF)				Justification for adjustment factor
R	1	2	3	R = 1 is AF for same order and trophic level R = 2 is AF for different order and same trophic level R = 3 is AF for different order and trophic level
I	1	1	1	
Q ₁	1	1	1	Reproductive performance (# of kits born). Ecologically relevant endpoint
Q ₂	1	1	1	Chronic duration (4.5 months)
Q ₃	1	1	1	NOAEL
U	1	1	1	Three dose levels (1, 5, and 15 ppm). Aroclor 1254 at 5 & 15 ppm in the diet reduced the number of offspring born alive.
Total AF	1	2	3	$R * I * Q_1 * Q_2 * Q_3 * U = \text{Total AF}$
QCE (mg/kg-day)	0.137	0.137	0.137	QCE = quantified critical endpoint
TRV	0.137	0.068	0.046	Toxicity Reference Value = QCE/Total AF

R Value	TRV (mg/kg-day)	Justification	Appropriate Functional Group
1	0.137	Test organism is in the same order and trophic level as the functional group members	M322
2	0.068	Test organism is in a different order and same trophic level from the functional group members	none
3	0.046	Test organism is in a different order and trophic level from the functional group members	M121, M122, M122A, M123, M210, M210A, M222, M422, M422A

COPC:**PCBs (Aroclor 1254) CAS 11097-69-1****Test Organisms:**

Mink (Carnivore, Order-Carnivora)

Exposure Medium:

Diet (Great Lakes fish)

Test Endpoint:

NOAEL

Reference:Hornshaw, T.C., R.J. Aulerich, and H.E. Johnson, 1983, *Feeding Great Lakes Fish to Mink: Effects on Mink and Accumulation and Elimination of PCBs by Mink*, *Journal of Toxicology and Environmental Health*, 11:933-946.**QCE:**

0.03 mg/kg-day

0.21 ppm in diet, 0.15 kg/kg BW food factor for mink (EPA, 1993)

Adjustment Factors (AF)				Justification for adjustment factor
R	1	2	3	R = 1 is AF for same order and trophic level R = 2 is AF for different order and same trophic level R = 3 is AF for different order and trophic level
I	1	1	1	Adequate numbers tested. During the first year, 96 subadult mink were randomly assigned to 1 of six dietary groups (4 males and 12 females). First year: control, perch, sucker, carp, whitefish, and alewife. Second year 28 females assigned to either a std mink or perch & sucker diet. Results of this study comparable to many others as mentioned in text.
Q ₁	1	1	1	Body weights of adults and offspring, reproductive performance (# of females whelped, kits whelped), liver weights. Ecologically relevant endpoint
Q ₂	1	1	1	Chronic duration (39 weeks)
Q ₃	1	1	1	NOAEL
U	2	2	2	Study provides a somewhat realistic means of exposure to mink, which are known to be considerably more sensitive to the toxicity of PCBs and related compounds than other mammalian carnivores, but study estimates based on different feeding diets.
Total AF	2	4	6	$R * I * Q_1 * Q_2 * Q_3 * U = \text{Total AF}$
QCE (mg/kg-day)	0.03	0.03	0.03	QCE = quantified critical endpoint
TRV	0.015	0.008	0.005	Toxicity Reference Value = QCE/Total AF

R Value	TRV (mg/kg-day)	Justification	Appropriate Functional Group
1	.015	Test organism is in the same order and trophic level as the functional group members	M322
2	.008	Test organism is in a different order and same trophic level from the functional group members	none
3	.005	Test organism is in a different order and trophic level from the functional group members	M121, M122, M122A, M123, M210, M210A, M222, M422, M422A

COPC: PCBs (Aroclor 1254) CAS 11097-69-1

Test Organisms: Oldfield mouse (Omnivore, Order-Rodentia)

Exposure Medium: Oral in diet

Test Endpoint: FEL

Reference: McCoy, G., et al., 1995. Chronic polychlorinated biphenyls exposure on three generations of oldfield mice (*Peromyscus polionotus*): effects on reproduction, growth, and body residues. *Arch. Environ. Contam. Toxicol.* 28:431-435.

QCE: 0.68 mg/kg-day Body weight: 0.014 kg (from Silva and Downing 1995), ingestion rate 0.135 g food/g BW/day.

Adjustment Factors (AF)				Justification for adjustment factor
R	1	2	3	R = 1 is AF for same order and trophic level R = 2 is AF for different order and same trophic level R = 3 is AF for different order and trophic level
I	1	1	1	Well-designed long-term study showed relatively low variability in response
Q ₁	1	1	1	# of litters, offspring weights and survival. Ecologically relevant endpoint
Q ₂	1	1	1	Chronic duration (12 months, >1 yr. and during a critical life stage)
Q ₃	3	3	3	FEL
U	3	3	3	Only one dose level.
Total AF	9	18	27	$R * I * Q_1 * Q_2 * Q_3 * U = \text{Total AF}$
QCE (mg/kg-day)	0.68	0.68	0.68	QCE = quantified critical endpoint
TRV	0.076	0.038	0.025	Toxicity Reference Value = QCE/Total AF

R Value	TRV (mg/kg-day)	Justification	Appropriate Functional Group
1	0.076	Test organism is in the same order and trophic level as the functional group members	none
2	0.038	Test organism is in a different order and same trophic level from the functional group members	M422, M422A
3	0.025	Test organism is in a different order and trophic level from the functional group members	M121, M122, M122A, M132, M210, M210A, M222, M322

Linzey, A.V. 1987, "Effects of chronic polychlorinated biphenyls exposure on reproductive success of white-footed mice (*Peromyscus leucopus*)."
Arch. Environ. Contamin. Toxicol. 16: 455-460.

COPC: Pyrene CAS 129-00-0

Test Organisms: Mouse (Omnivore, Order-Rodentia)

Exposure Medium: Oral in diet

Test Endpoint: NOAEL

Reference: EPA, 1989, *Mouse Oral Subchronic Toxicity of Pyrene*. Study conducted by Toxicity Research Laboratories, Muskegon, MI for the Office of Solid Waste, Washington DC.

QCE: 75 mg/kg/day (Specified)

Adjustment Factors (AF)				Justification for adjustment factor
R	1	2	3	R = 1 is AF for same order and trophic level R = 2 is AF for different order and same trophic level R = 3 is AF for different order and trophic level
I	2	2	2	Relatively small group sizes, variability not addressed
Q ₁	0.5	0.5	0.5	Although endpoint could occur in ROC, the ecological relevance is questionable since kidney lesions were mild.
Q ₂	1	1	1	Chronic study (13 weeks)
Q ₃	1	1	1	NOAEL endpoint
U	2	2	2	No reproductive endpoints examined
Total AF	2	4	6	$R * I * Q_1 * Q_2 * Q_3 * U = \text{Total AF}$
QCE (mg/kg-day)	75	75	75	QCE = quantified critical endpoint
TRV	38	19	13	Toxicity Reference Value = QCE/Total AF

R Value	TRV (mg/kg-day)	Justification	Appropriate Functional Group
1	38	Test organism is in the same order and trophic level as the functional group members	none
2	19	Test organism is in a different order and same trophic level from the functional group members	M422, M422A
3	13	Test organism is in a different order and trophic level from the functional group members	M121, M122, M122A, M132, M210, M210A, M222, M322

COPC:**Selenium (Sodium selenite) CAS 7782-49-2****Test Organisms:**

Chicken (Omnivore, Order-Galliformes)

Exposure Medium:

Diet

Test Endpoint:

NOAEL

Reference

Ort, J.F. and J.D. Latshaw, 1978, "The toxic level of sodium selenite in the diet of laying chickens," *Journal of Nutrition*, 108:1114-1120.
 EPA, 1993, Ch. 9. Selenium Effects at Kesterson Reservoir, A Review of Ecological Assessment Case Studies from a Risk Assessment Perspective, EPA/630/R-92/005.
 Eisler, R. 1985, Selenium Hazards to Fish, Wildlife, and Invertebrates: A Synoptic Review, U.S. Fish and Wildlife Service, Biological Report, 85(1.5).

QCE:

0.198 mg/kg-day

 $(3\text{mg/kg}) \cdot (0.132\text{kg/hen-day}) / 2\text{kg BW}$

Adjustment Factors (AF)				Justification for adjustment factor
R	1	2	3	R = 1 is AF for same order and trophic level R = 2 is AF for different order and same trophic level R = 3 is AF for different order and trophic level
I	1	1	1	Adequate numbers tested (100 female birds) and results are consistent with other studies in chickens and quail
Q ₁	1	1	1	Endpoint ecologically relevant: egg production, egg weight and fertility, hatchability
Q ₂	1	1	1	Chronic study
Q ₃	1	1	1	NOAEL endpoint
U	2	2	2	Older study but good design, however only females were tested
Total AF	2	4	6	$R \cdot I \cdot Q_1 \cdot Q_2 \cdot Q_3 \cdot U = \text{Total AF}$
QCE (mg/kg-day)	0.198	0.198	0.198	QCE = quantified critical endpoint
TRV	0.099	0.050	0.033	Toxicity Reference Value = QCE/Total AF

R Value	TRV (mg/kg-day)	Justification	Appropriate Functional Group
1	0.099	Test organism is in the same order and trophic level as the functional group members	none
2	0.050	Test organism is in a different order and same trophic level from the functional group members	AV422, AV432, AV433, AV442
3	0.033	Test organism is in a different order and trophic level from the functional group members	AV121, AV122, AV132, AV142, AV143, AV210, AV210A, AV221, AV222, AV222A, AV232, AV233, AV241, AV242, AV310, AV322, AV333, AV342

**Ingestion rate specified in table 2 page 1116 of article

COPC: Selenium (Sodium selenite) CAS 7782-49-2

Test Organisms: Mallard (Herbivore, Order-Anseriformes)

Exposure Medium: Diet

Test Endpoint: NOAEL

Reference: Heinz, G.H. et al. 1987, "Reproduction in mallards fed selenium," Environmental Toxicology and Chemistry, 6:423-433.
Eisler, R. 1985, Selenium Hazards to Fish, Wildlife, and Invertebrates: A Synoptic Review, U.S. Fish and Wildlife Service, Biological Report, 85(1.5).
EPA. 1993, Ch. 9. Selenium Effects at Kesterson Reservoir, A Review of Ecological Assessment Case Studies from a Risk Assessment Perspective, EPA/630/R-92/005.

QCE: 0.5 mg/kg-day (5 mg/kg * 0.1 kg feed)/ 1 kg bird

Adjustment Factors (AF)				Justification for adjustment factor
R	1	2	3	R = 1 is AF for same order and trophic level R = 2 is AF for different order and same trophic level R = 3 is AF for different order and trophic level
I	2	2	2	10 pairs for five doses tested, study results consistent with other studies in chickens and quail, repro/devel. toxicity analysis only.
Q ₁	1	1	1	Ecologically relevant endpoint (egg hatchability)
Q ₂	1	1	1	Chronic study (2-4 mos.)
Q ₃	1	1	1	NOAEL endpoint
U	1	1	1	Reproductive study only with different forms of selenium
Total AF	2	4	6	$R * I * Q_1 * Q_2 * Q_3 * U = \text{Total AF}$
QCE (mg/kg-day)	0.5	0.5	0.5	QCE = quantified critical endpoint
TRV	0.25	0.13	0.08	Toxicity Reference Value = QCE/Total AF

R Value	TRV (mg/kg-day)	Justification	Appropriate Functional Group
1	0.25	Test organism is in the same order and trophic level as the functional group members	AV142, AV143
2	0.13	Test organism is in a different order and same trophic level from the functional group members	AV121, AV122, AV132
3	0.08	Test organism is in a different order and trophic level from the functional group members	AV210, AV210A, AV221, AV222, AV222A, AV232, AV233, AV241, AV242, AV310, AV322, AV333, AV342, AV422, AV432, AV433, AV442

COPC: Selenium CAS 7782-49-2

Test Organisms: Rat (Omnivore, Order-Rodentia)

Exposure Medium: Diet

Test Endpoint: NOAEL

Reference: Rosenfeld, I. and O.A. Beath. 1954. Effect of selenium on reproduction in rats. Proc. Soc. Exp. Biol. Med. 87:295-297.

QCE: 0.075 mg/kg-day (Specified)

Adjustment Factors (AF)				Justification for adjustment factor
R	1	2	3	R = 1 is AF for same order and trophic level R = 2 is AF for different order and same trophic level R = 3 is AF for different order and trophic level
I	1	1	1	Chronic toxicity studies with adequate numbers of animals
Q ₁	1	1	1	Ecologically relevant endpoint (reproduction, number of young reared)
Q ₂	1	1	1	Chronic study
Q ₃	1	1	1	NOAEL endpoint
U	1	1	1	Older study, but analyzed 5 breeding cycles and 2 generations. A more recent study by Nobunaga et al. (1979) reports a NOAEL of 390 ug/kg/day selenite for mice reproductive success.
Total AF	1	2	3	$R * I * Q_1 * Q_2 * Q_3 * U = \text{Total AF}$
QCE (mg/kg-day)	0.075	0.075	0.075	QCE = quantified critical endpoint
TRV	0.075	0.038	0.025	Toxicity Reference Value = QCE/Total AF

R Value	TRV (mg/kg-day)	Justification	Appropriate Functional Group
1	0.075	Test organism is in the same order and trophic level as the functional group members	none
2	0.038	Test organism is in a different order and same trophic level from the functional group members	M422, M422A
3	0.025	Test organism is in a different order and trophic level from the functional group members	M121, M122, M122A, M132, M210, M210A, M222, M322

COPC:**Selenium CAS 7782-49-2****Test Organisms:**

Mouse (Omnivore, Order-Rodentia)

Exposure Medium:

Oral in water

Test Endpoint:

FEL

Reference:Schroeder and Mitchner 1971. Toxic effects of trace elements on the reproduction of mice and rats. *Arch. Environ. Health*. 23: 102-106.**QCE:**

0.76 mg/kg-day

Adjustment Factors (AF)				Justification for adjustment factor
R	1	2	3	R = 1 is AF for same order and trophic level R = 2 is AF for different order and same trophic level R = 3 is AF for different order and trophic level
I	2	2	2	Adequate numbers of females (104) tested, no males or juveniles tested.
Q ₁	1	1	1	Ecologically relevant endpoint (reproduction, number of young reared)
Q ₂	1	1	1	Chronic study (3 generations)
Q ₃	3	3	3	FEL endpoint (only one dose examined)
U	2	2	2	Good design, only reproductive endpoints (fetus) examined.
M	0.5	0.5	0.5	Placed in drinking water.
Total AF	6	12	18	$R * I * Q_1 * Q_2 * Q_3 * U = \text{Total AF}$
QCE (mg/kg-day)	0.76	0.76	0.76	QCE = quantified critical endpoint
TRV	0.13	0.06	0.04	Toxicity Reference Value = QCE/Total AF

R Value	TRV (mg/kg-day)	Justification	Appropriate Functional Group
1	0.13	Test organism is in the same order and trophic level as the functional group members	none
2	0.06	Test organism is in a different order and same trophic level from the functional group members	M422, M422A
3	0.04	Test organism is in a different order and trophic level from the functional group members	M121, M122, M122A, M132, M210, M210A, M222, M322

*ingestion rate and BW specified in article

COPC: Selenium CAS 7782-49-2

Test Organisms: Sheep (Herbivore, Order-Artiodactyla)

Exposure Medium: Diet

Test Endpoint: FEL

Reference: Eisler, R. 1985, Selenium Hazards to Fish, Wildlife, and Invertebrates: A Synoptic Review, U.S. Fish and Wildlife Service, Biological Report, 85(1.5).

QCE: 3.2 mg/kg-day (Specified)

Adjustment Factors (AF)				Justification for adjustment factor
R	1	2	3	R = 1 is AF for same order and trophic level R = 2 is AF for different order and same trophic level R = 3 is AF for different order and trophic level
I	3	3	3	Secondary source
Q ₁	1	1	1	Ecologically relevant endpoint (mortality)
Q ₂	3	3	3	Acute study
Q ₃	3	3	3	FEL - Lethal endpoint
U	3	3	3	Secondary source
Total AF	81	162	243	$R * I * Q_1 * Q_2 * Q_3 * U = \text{Total AF}$
QCE (mg/kg-day)	3.2	3.2	3.2	QCE = quantified critical endpoint
TRV	0.04	0.02	0.01	Toxicity Reference Value = QCE/Total AF

R Value	TRV (mg/kg-day)	Justification	Appropriate Functional Group
1	0.04	Test organism is in the same order and trophic level as the functional group members	none
2	0.02	Test organism is in a different order and same trophic level from the functional group members	M121, M122, M122A, M123, M132
3	0.01	Test organism is in a different order and trophic level from the functional group members	M210, M210A, M222, M322, M422, M422A

COPC: Selenium CAS 7782-49-2

Test Organisms: Black-crowned Night Heron

Exposure Medium: Diet

Test Endpoint: LOAEL

Reference: Smith, G.J., et al., 1988, "Reproduction in Black-Crowned Night-Herons Fed Selenium." *Lake and Reservoir Mgmt.* 4(2):175-180.

QCE: 2.5 mg/kg-day 10 mg/kg in diet converted to dose by multiplying by 0.212 kg/day ingestion rate and dividing by 0.85 kg BW

Adjustment Factors (AF)				Justification for adjustment factor
R	1	2	3	R = 1 is AF for same order and trophic level R = 2 is AF for different order and same trophic level R = 3 is AF for different order and trophic level
I	2	2	2	Adequate numbers of males and females tested (12 pairs), study results consistent with other studies in chickens and quails.
Q ₁	1	1	1	Hatching success, organ weights, blood measures, eggshell thickness, however 3-day-old hatchlings had shorter femurs and radius ulna legs and other hematological effects.
Q ₂	1	1	1	Chronic study
Q ₃	2	2	2	LOAEL
U	2	2	2	No NOAEL established. Reproductive endpoints examined.
Total AF	8	16	24	$R * I * Q_1 * Q_2 * Q_3 * U = \text{Total AF}$
QCE (mg/kg-day)	2.5	2.5	2.5	QCE = quantified critical endpoint
TRV	0.31	0.16	0.10	Toxicity Reference Value = QCE/Total AF

R Value	TRV (mg/kg-day)	Justification	Appropriate Functional Group
1	0.31	Test organism is in the same order and trophic level as the functional group members	none
2	0.16	Test organism is in a different order and same trophic level from the functional group members	AV310, AV322, AV322A, AV333, AV342
3	0.10	Test organism is in a different order and trophic level from the functional group members	AV121, AV122, AV132, AV142, AV143, AV210, AV210A, AV221, AV222, AV222AAV232, AV233, AV241, AV242, AV432, AV432A, AV442

COPC: Silver CAS 7440-22-4

Test Organisms: Mouse (Omnivore, Order-Rodentia)

Exposure Medium: Drinking Water

Test Endpoint: FEL

Reference: Rungby and Danscher, 1984, "Hypoactivity in silver exposed mice," Acta Pharmacol and Toxicol, 55(5):398-401.

QCE: 3.0 mg/kg-day (0.09 mg/ 0.03 kg)

Adjustment Factors (AF)				Justification for adjustment factor
R	1	2	3	R = 1 is AF for same order and trophic level R = 2 is AF for different order and same trophic level R = 3 is AF for different order and trophic level
I	2	2	2	Females only for the long-term study
Q ₁	0.1	0.1	0.1	Not clearly relevant endpoint
Q ₂	2	2	2	Subchronic duration
Q ₃	3	3	3	FEL
U	2	2	2	Only one dose, no NOAEL identified.
M	0.5	0.5	0.5	Placed in drinking water
Total AF	1.2	2.4	3.6	$R * I * Q_1 * Q_2 * Q_3 * U = \text{Total AF}$
QCE (mg/kg-day)	3	3	3	QCE = quantified critical endpoint
TRV	2.5	1.3	0.8	Toxicity Reference Value = QCE/Total AF

R Value	TRV (mg/kg-day)	Justification	Appropriate Functional Group
1	2.5	Test organism is in the same order and trophic level as the functional group members	none
2	1.3	Test organism is in a different order and same trophic level from the functional group members	M422, M422A
3	0.8	Test organism is in a different order and trophic level from the functional group members	M121, M122, M122A, M132, M210, M210A, M222, M322

COPC: Sulfate CAS 14808-79-8

Test Organisms: Rat (Omnivore, Order-Rodentia)

Exposure Medium: Oral in diet

Test Endpoint: LD₉₀

Reference: Venugopal, B. and T.D. Luckey, 1978. *The Toxicity of Metals in Mammals*, New York, Plenum Press.

QCE: 1,292 mg/kg-day (from potassium sulfate)

Adjustment Factors (AF)				Justification for adjustment factor
R	1	2	3	R = 1 is AF for same order and trophic level R = 2 is AF for different order and same trophic level R = 3 is AF for different order and trophic level
I	3	3	3	Secondary source so information on number and sexes of animals tested unknown.
Q ₁	1	1	1	Ecologically relevant endpoint (lethality)
Q ₂	3	3	3	Duration of exposure unknown
Q ₃	3	3	3	FEL – lethality
U	3	3	3	Limited information and reproductive endpoints and sensitive life stages examined. No NOAEL established.
Total AF	81	162	243	$R * I * Q_1 * Q_2 * Q_3 * U = \text{Total AF}$
QCE (mg/kg-day)	1292	1292	1292	QCE = quantified critical endpoint
TRV	15.95	7.98	5.32	Toxicity Reference Value = QCE/Total AF

R Value	TRV (mg/kg-day)	Justification	Appropriate Functional Group
1	15.95	Test organism is in the same order and trophic level as the functional group members	none
2	7.98	Test organism is in a different order and same trophic level from the functional group members	M422, M422A
3	5.32	Test organism is in a different order and trophic level from the functional group members	M121, M122, M122A, M132, M210, M210A, M222, M322

COPC: Sulfate

Test Organisms: Turkeys (Omnivore, Order-Galliformes)

Exposure Medium: Oral in diet

Test Endpoint: NOAEL

Reference: Cakir, A., T.W. Sullivan, and F.B. Mather, 1978. Alleviation of fluorine toxicity in starting turkeys and chicks with aluminum. Poultry Science 57:498, as cited in National Academy of Sciences, 1980. Mineral Tolerance of Domestic Animals. Washington, DC.

QCE: 207.4 mg/kg-day (from aluminum sulfate)

Adjustment Factors (AF)				Justification for adjustment factor
R	1	2	3	R = 1 is AF for same order and trophic level R = 2 is AF for different order and same trophic level R = 3 is AF for different order and trophic level
I	2	2	2	1-day old turkeys tested. Secondary source so information on number of animals tested not available.
Q ₁	1	1	1	Endpoint ecologically relevant
Q ₂	2	2	2	Subchronic study (28 days)
Q ₃	1	1	1	NOAEL
U	2	2	2	Limited information. Sensitive life stage examined. NOAEL established. Test organisms exposed to Al ₂ (SO ₄)·18H ₂ O
Total AF	8	16	24	$R * I * Q_1 * Q_2 * Q_3 * U = \text{Total AF}$
QCE (mg/kg-day)	207.4	207.4	207.4	QCE = quantified critical endpoint
TRV	25.93	12.96	8.64	Toxicity Reference Value = QCE/Total AF

R Value	TRV (mg/kg-day)	Justification	Appropriate Functional Group
1	25.93	Test organism is in the same order and trophic level as the functional group members	none
2	12.96	Test organism is in a different order and same trophic level from the functional group members	AV422, AV432, AV433, AV442
3	8.64	Test organism is in a different order and trophic level from the functional group members	AV121, AV122, AV132, AV142, AV143, AV210, AV210A, AV221, AV222, AV222A, AV232, AV233, AV241, AV242, AV310, AV322, AV333, AV342

COPC: **Thallium CAS 7440-28-0**

Test Organisms: Quail (Omnivore, Order-Galliformes)

Exposure Medium: Oral in diet (bread)

Test Endpoint: FEL

Reference: Shaw, P.A., 1933, "Toxicity and deposition of thallium in certain game birds," Journal of Pharmacology and Experimental Therapeutics, 48(4):478-487.

QCE: 12 mg/kg

Adjustment Factors (AF)				Justification for adjustment factor
R	1	2	3	R = 1 is AF for same order and trophic level R = 2 is AF for different order and same trophic level R = 3 is AF for different order and trophic level
I	3	3	3	Very old study, doses and effects poorly characterized, only high doses and lethal endpoints considered
Q ₁	1	1	1	Ecologically relevant endpoint (lethality)
Q ₂	3	3	3	Acute duration
Q ₃	3	3	3	FEL for lethality
U	3	3	3	Very old study, poorly designed and analyzed
Total AF	81	162	243	$R * I * Q_1 * Q_2 * Q_3 * U = \text{Total AF}$
QCE (mg/kg-day)	12	12	12	QCE = quantified critical endpoint
TRV	0.15	0.07	0.05	Toxicity Reference Value = QCE/Total AF

R Value	TRV (mg/kg-day)	Justification	Appropriate Functional Group
1	0.15	Test organism is in the same order and trophic level as the functional group members	none
2	0.07	Test organism is in a different order and same trophic level from the functional group members	AV422, AV432, AV433, AV442
3	0.05	Test organism is in a different order and trophic level from the functional group members	AV121, AV122, AV132, AV142, AV143, AV210, AV210A, AV221, AV222, AV222A, AV232, AV233, AV241, AV242, AV310, AV322, AV333, AV342

*Ingestion rate from Wildlife Exposure Factors Handbook and BW from Weimeyer article

**note-in the article the units on the 12 were just mg/kg...it was assumed that that meant kg of food.

COPC:**Thallium CAS 7440-28-0****Test Organisms:**

Rat (Omnivore, Order-Rodentia)

Exposure Medium:

Oral in Diet

Test Endpoint:

LOAEL Hair loss

Reference:Downs, W., Scott, J., Steadman, L., Maynard, E., 1960, "Acute and Sub-acute Toxicity Studies of Thallium Compounds", *Industrial Hygiene Journal*, pp. 399-406.**QCE:**

1.8mg/kg-day

Specified (Average between 1-3 depending on the BW)

Adjustment Factors (AF)				Justification for adjustment factor
R	1	2	3	R = 1 is AF for same order and trophic level R = 2 is AF for different order and same trophic level R = 3 is AF for different order and trophic level
I	2	2	2	Smaller number of male and female rats tested, no juveniles tested.
Q ₁	1	1	1	Ecologically relevant endpoint
Q ₂	2	2	2	Subchronic duration
Q ₃	2	2	2	LOAEL
U	2	2	2	Good design, a variety of compounds tested, reproductive endpoints not examined. Compound is thallium acetate. Similar responsiveness for thallium oxide.
Total AF	16	32	48	$R * I * Q_1 * Q_2 * Q_3 * U = \text{Total AF}$
QCE (mg/kg-day)	1.8	1.8	1.8	QCE = quantified critical endpoint
TRV	0.11	0.06	0.04	Toxicity Reference Value = QCE/Total AF

R Value	TRV (mg/kg-day)	Justification	Appropriate Functional Group
1	0.11	Test organism is in the same order and trophic level as the functional group members	none
2	0.06	Test organism is in a different order and same trophic level from the functional group members	M422, M422A
3	0.04	Test organism is in a different order and trophic level from the functional group members	M121, M122, M122A, M132, M210, M210A, M222, M322

COPC:**Thallium CAS 7440-28-0****Test Organisms:**

Rat (Omnivore, Order-Rodentia)

Exposure Medium:

Drinking Water

Test Endpoint:

FEL Reduced sperm motility, etc.

Reference:Formigli, L., et al., 1986, "Thallium-induced testicular toxicity in the rat,"
Environmental Research, 40(2):531-539.**QCE:**0.75mg/kg-day Daily intake of 0.27 mg/rat, each rat weighing an avg.
of 0.35 kg BW

Adjustment Factors (AF)				Justification for adjustment factor
R	1	2	3	R = 1 is AF for same order and trophic level R = 2 is AF for different order and same trophic level R = 3 is AF for different order and trophic level
I	1	1	1	Well characterized effects, consistent results among groups, only male reproduction toxicity was evaluated.
Q ₁	1	1	1	Ecologically relevant endpoint
Q ₂	2	2	2	Subchronic duration
Q ₃	3	3	3	FEL based on reproductive effects
U	2	2	2	Only one dose, no NOAEL identified
M	0.5	0.5	0.5	Placed in drinking water
Total AF	6	12	18	$R * I * Q_1 * Q_2 * Q_3 * U = \text{Total AF}$
QCE (mg/kg-day)	0.75	0.75	0.75	QCE = quantified critical endpoint
TRV	0.13	0.06	0.04	Toxicity Reference Value = QCE/Total AF

R Value	TRV (mg/kg-day)	Justification	Appropriate Functional Group
1	0.13	Test organism is in the same order and trophic level as the functional group members	none
2	0.06	Test organism is in a different order and same trophic level from the functional group members	M422, M422A
3	0.04	Test organism is in a different order and trophic level from the functional group members	M121, M122, M122A, M132, M210, M210A, M222, M322

COPC:**Vanadium (Vanadyl sulfate) CAS 27774-13-6****Test Organisms:**

Chicken (Omnivore, Order-Galliformes)

Exposure Medium:

Diet

Test Endpoint:

NOAEL

Reference:Kubena, L.F. and T.D. Phillips, 1982, "Toxicity of vanadium in female leghorn chickens," Poultry Science, 62:47-50.**QCE:**

1.7 mg/kg-day

25 ppm in diet converted to dose using an estimated 0.1 kg/day ingestion rate and 1.5 kg BW as indicated in study

Adjustment Factors (AF)				Justification for adjustment factor
R	1	2	3	R = 1 is AF for same order and trophic level R = 2 is AF for different order and same trophic level R = 3 is AF for different order and trophic level
I	1	1	1	Subchronic study with adequate numbers of animals
Q ₁	1	1	1	Endpoint ecologically relevant (growth and egg production)
Q ₂	2	2	2	Subchronic duration
Q ₃	1	1	1	NOAEL
U	2	2	2	Multiple doses evaluated, good statistical analysis of data, but only weight and egg production were evaluated.
Total AF	4	8	12	$R * I * Q_1 * Q_2 * Q_3 * U = \text{Total AF}$
QCE (mg/kg-day)	1.7	1.7	1.7	QCE = quantified critical endpoint
TRV	0.43	0.21	0.14	Toxicity Reference Value = QCE/Total AF

R Value	TRV (mg/kg-day)	Justification	Appropriate Functional Group
1	0.43	Test organism is in the same order and trophic level as the functional group members	none
2	0.21	Test organism is in a different order and same trophic level from the functional group members	AV422, AV432, AV433, AV442
3	0.14	Test organism is in a different order and trophic level from the functional group members	AV121, AV122, AV132, AV142, AV143, AV210, AV210A, AV221, AV222, AV222A, AV232, AV233, AV241, AV242, AV310, AV322, AV333, AV342

**FI=0.0582(BW)^{0.651} cited in EPA Wildlife Exposures Handbook

COPC:**Vanadium (Vanadyl sulfate) CAS 27774-13-6****Test Organisms:**

Mallard (Herbivore, Order-Anseriformes)

Exposure Medium:

Diet

Test Endpoint:

NOAEL

Reference:White, D.H. and M.P. Dieter, 1978, "Effects of dietary vanadium in mallard ducks. Journal of Toxicology and Environmental Health.**QCE:**

1.0 mg/kg-day 10 ppm in diet converted to dose using 0.121 kg/day ingestion rate and 1.17 kg BW as indicated in study.

Adjustment Factors (AF)				Justification for adjustment factor
R	1	2	3	R = 1 is AF for same order and trophic level R = 2 is AF for different order and same trophic level R = 3 is AF for different order and trophic level
I	2	2	2	Subchronic study with adequate numbers of animals
Q ₁	0.5	0.5	0.5	Ecological relevance of endpoint questionable (altered lipid metabolism)
Q ₂	2	2	2	Subchronic duration
Q ₃	1	1	1	NOAEL
U	2	2	2	No reproductive endpoint evaluated, multiple doses evaluated
Total AF	4	8	12	$R * I * Q_1 * Q_2 * Q_3 * U = \text{Total AF}$
QCE (mg/kg-day)	1.0	1.0	1.0	QCE = quantified critical endpoint
TRV	0.25	0.13	0.08	Toxicity Reference Value = QCE/Total AF

R Value	TRV (mg/kg-day)	Justification	Appropriate Functional Group
1	0.25	Test organism is in the same order and trophic level as the functional group members	AV142, AV143
2	0.13	Test organism is in a different order and same trophic level from the functional group members	AV121, AV122, AV132
3	0.08	Test organism is in a different order and trophic level from the functional group members	AV210, AV210A, AV221, AV222, AV222A, AV232, AV233, AV241, AV242, AV310, AV322, AV333, AV342, AV422, AV432, AV433, AV442

COPC:**Vanadium (Vanadyl sulfate) CAS 27774-13-6****Test Organisms:**

Mouse (Omnivore, Order-Rodentia)

Exposure Medium:

Diet

Test Endpoint:

NOAEL

Reference:Schroeder, H.A. and J.J. Balassa, 1967, "Arsenic, germanium, tin and vanadium in mice: Effects on growth, survival and tissue levels," *Journal of Nutrition*, 92:245-252.

ATSDR. Agency for Toxic Substance Disease Registry. 1990. Draft: Toxicological Profile for Vanadium. October, 1990.

QCE:

4.1 mg/kg-day

Adjustment Factors (AF)				Justification for adjustment factor
R	1	2	3	R = 1 is AF for same order and trophic level R = 2 is AF for different order and same trophic level R = 3 is AF for different order and trophic level
I	1	1	1	108 males and females tested
Q ₁	1	1	1	Ecologically relevant endpoint (body weight gain)
Q ₂	1	1	1	Chronic duration
Q ₃	1	1	1	NOAEL
U	3	3	3	Older study, reproductive endpoints and sensitive life stage not examined,. Only one dose was tested, no LOAEL found.
Total AF	3	6	9	$R * I * Q_1 * Q_2 * Q_3 * U = \text{Total AF}$
QCE (mg/kg-day)	4.1	4.1	4.1	QCE = quantified critical endpoint
TRV	1.37	0.68	0.46	Toxicity Reference Value = QCE/Total AF

R Value	TRV (mg/kg-day)	Justification	Appropriate Functional Group
1	1.37	Test organism is in the same order and trophic level as the functional group members	none
2	0.68	Test organism is in a different order and same trophic level from the functional group members	M422, M422A
3	0.46	Test organism is in a different order and trophic level from the functional group members	M121, M122, M122A, M132, M210, M210A, M222, M322

COPC:**Vanadium** (Ammonium metavanadate) CAS 7803-55-6**Test Organisms:**

Bovine (calves)

Exposure Medium:

Gelatin capsule

Test Endpoint:

NOAEL Clinical symptoms

Reference:Platonow, N. and H.K. Abbey, 1968, "Toxicity of Vanadium in Calves". *Vet. Record*, 82:292.**QCE:**

7.5 mg/kg-day

Adjustment Factors (AF)				Justification for adjustment factor
R	1	2	3	R = 1 is AF for same order and trophic level R = 2 is AF for different order and same trophic level R = 3 is AF for different order and trophic level
I	2	2	2	10 young males
Q ₁	1	1	1	Ecologically relevant endpoint.
Q ₂	2	2	2	Subchronic duration
Q ₃	1	1	1	NOAEL
U	2	2	2	Older study, reproductive and sensitive endpoints not evaluated.
Total AF	8	16	24	$R * I * Q_1 * Q_2 * Q_3 * U = \text{Total AF}$
QCE (mg/kg-day)	7.5	7.5	7.5	QCE = quantified critical endpoint
TRV	0.94	0.47	0.31	Toxicity Reference Value = QCE/Total AF

R Value	TRV (mg/kg-day)	Justification	Appropriate Functional Group
1	0.94	Test organism is in the same order and trophic level as the functional group members	none
2	0.47	Test organism is in a different order and same trophic level from the functional group members	M121, M122, M122A, M123, M132
3	0.31	Test organism is in a different order and trophic level from the functional group members	M210, M210A, M222, M322, M422, M422A

COPC: Xylene CAS 1330-20-7

Test Organisms: Mouse (Omnivore, Order-Rodentia)

Exposure Medium: Oral (gavage)

Test Endpoint: NOAEL

Reference: Marks, T., Ledoux, T., and Moore, J., 1982, "Teratogenicity of a Commercial Xylene Mixture in the Mouse", *J Toxi. Environ. Health*, 9:97.

QCE: 2.06 mg/kg-day (Specified)

Adjustment Factors (AF)				Justification for adjustment factor
R	1	2	3	R = 1 is AF for same order and trophic level R = 2 is AF for different order and same trophic level R = 3 is AF for different order and trophic level
I	2	2	2	Only females during gestation given the doses, no males or juveniles tested.
Q ₁	1	1	1	Ecologically relevant endpoint (mortality/histopathologic effects)
Q ₂	2	2	2	Subchronic exposure for pups (days 6-15 of gestation)
Q ₃	1	1	1	NOAEL
U	2	2	2	Well designed study, 3 replicates done, sensitive life stage and reproductive endpoint tested but pup neurotox. and neurodevelopment are probably more sensitive endpoints.
Total AF	8	16	24	$R * I * Q_1 * Q_2 * Q_3 * U = \text{Total AF}$
QCE (mg/kg-day)	2.06	2.06	2.06	QCE = quantified critical endpoint
TRV	0.258	0.129	0.086	Toxicity Reference Value = QCE/Total AF

R Value	TRV (mg/kg-day)	Justification	Appropriate Functional Group
1	0.258	Test organism is in the same order and trophic level as the functional group members	none
2	0.129	Test organism is in a different order and same trophic level from the functional group members	M422, M422A
3	0.086	Test organism is in a different order and trophic level from the functional group members	M121, M122, M122A, M132, M210, M210A, M222, M322

COPC:**Xylene CAS 1330-20-7****Test Organisms:**

Rat (Omnivore, Order-Rodentia)

Exposure Medium:

Oral (gavage)

Test Endpoint:

NOAEL

Reference:

National Toxicology Program (NTP), 1986, *NTP Technical Report on the Toxicology and Carcinogenesis of Xylene (Mixed) (60.2% m-Xylene, 13.6% p-Xylene, 17.0% Ethylbenzene, and 9.1% o-Xylene) (CAS No. 1330-20-7) in F344N/N Rates and B6C3F1 Mice (Gavage Studies)*, NIH Publication No. 86-2583, Research Triangle Park, N.C.

QCE:

250 mg/kg-day

Adjustment Factors (AF)				Justification for adjustment factor
R	1	2	3	R = 1 is AF for same order and trophic level R = 2 is AF for different order and same trophic level R = 3 is AF for different order and trophic level
I	2	2	2	Adult males and females tested. No juveniles tested.
Q ₁	1	1	1	Ecologically relevant endpoint (mortality/histopathologic effects)
Q ₂	1	1	1	Chronic (103-week) exposure
Q ₃	1	1	1	NOAEL
U	2	2	2	Well-designed study with adequate numbers of animals from two species tested. Comprehensive histology was performed. A LOAEL was not determined.
Total AF	4	8	12	$R * I * Q_1 * Q_2 * Q_3 * U = \text{Total AF}$
QCE (mg/kg-day)	250	250	250	QCE = quantified critical endpoint
TRV	62.5	31.3	20.8	Toxicity Reference Value = QCE/Total AF

R Value	TRV (mg/kg-day)	Justification	Appropriate Functional Group
1	62.5	Test organism is in the same order and trophic level as the functional group members	none
2	31.3	Test organism is in a different order and same trophic level from the functional group members	M422, M422A
3	20.8	Test organism is in a different order and trophic level from the functional group members	M121, M122, M122A, M132, M210, M210A, M222, M322

COPC:**Zinc (zinc sulfate)** CAS 68813-94-5**Test Organisms:**

Chicken (Omnivore, Order-Galliformes)

Exposure Medium:

Diet

Test Endpoint:

LOAEL

Reference:Stahl, J.L., Greger, J.L., and M.E. Cook, 1990, "Breeding hen and progeny when hens are fed excessive dietary zinc," *Poultry Science*, 69:259-263.

Hoadley, J.E., S.H. Tao, and M.R. W. Fox, 1989, "Dietary cadmium and zinc effects on peripheral neuromuscular development," 73rd Annual Meeting of the Federation of American Societies for Experimental Biology, New Orleans, LA., March 19-23, 1989, Federation of American Society for Experimental Biology, 4929.

QCE:

12 mg/kg-day

20 mg/kg in diet converted to dose by 0.105 kg/day ingestion (from study) and 0.172 kg BW

Adjustment Factors (AF)				Justification for adjustment factor
R	1	2	3	R = 1 is AF for same order and trophic level R = 2 is AF for different order and same trophic level R = 3 is AF for different order and trophic level
I	1	1	1	Chronic study with adequate number of animals
Q ₁	1	1	1	Endpoint ecologically relevant (egg production)
Q ₂	1	1	1	Chronic duration
Q ₃	2	2	2	LOAEL
U	1	1	1	High quality study
Total AF	2	4	6	$R * I * Q_1 * Q_2 * Q_3 * U = \text{Total AF}$
QCE (mg/kg-day)	12	12	12	QCE = quantified critical endpoint
TRV	6.0	3.0	2.0	Toxicity Reference Value = QCE/Total AF

R Value	TRV (mg/kg-day)	Justification	Appropriate Functional Group
1	6.0	Test organism is in the same order and trophic level as the functional group members	none
2	3.0	Test organism is in a different order and same trophic level from the functional group members	AV422, AV432, AV433, AV442
3	2.0	Test organism is in a different order and trophic level from the functional group members	AV121, AV122, AV132, AV142, AV143, AV210, AV210A, AV221, AV222, AV222A, AV232, AV233, AV241, AV242, AV310, AV322, AV333, AV342

COPC: Zinc CAS 7440-66-6

Test Organisms: Ferret (Carnivore, Order-Carnivora)

Exposure Medium: Diet

Test Endpoint: NOAEL

Reference: Straube, E.F., Schuster, N.H., and Sinclair, A.J., 1980, "Zinc toxicity in the ferret," Journal of Comparative Pathology, 90:355-361.

QCE: 142 mg/kg-day 500mg/kg*0.170kg/day/0.60kgBW

Adjustment Factors (AF)				Justification for adjustment factor
R	1	2	3	R = 1 is AF for same order and trophic level R = 2 is AF for different order and same trophic level R = 3 is AF for different order and trophic level
I	3	3	3	NOAEL group was only 3 animals
Q ₁	1	1	1	Overall health, weight gain, hematological measurements, levels of zinc in organs
Q ₂	2	2	2	Subchronic duration (48, 138 and 191 days)
Q ₃	1	1	1	NOAEL
U	2	2	2	Adequate study design, but no reproductive endpoints examined.
Total AF	12	24	36	$R * I * Q_1 * Q_2 * Q_3 * U = \text{Total AF}$
QCE (mg/kg-day)	142	142	142	QCE = quantified critical endpoint
TRV	11.8	5.92	3.94	Toxicity Reference Value = QCE/Total AF

R Value	TRV (mg/kg-day)	Justification	Appropriate Functional Group
1	11.8	Test organism is in the same order and trophic level as the functional group members	M322
2	5.92	Test organism is in a different order and same trophic level from the functional group members	none
3	3.94	Test organism is in a different order and trophic level from the functional group members	M121, M122, M122A, M123, M210, M210A, M222, M422, M422A

COPC: Zinc CAS 68813-94-5

Test Organisms: Mallard (Herbivore, Order-Anseriformes)

Exposure Medium: Diet

Test Endpoint: LOAEL

Reference: Gasaway and Buss, 1972, "Zinc Toxicity in the Mallard Duck", *J. Wildl. Manage.*, 36:1107-1117.

QCE: 207 mg/kg-day (3000mg/kg food)*(0.0363kg/day)/(0.525 kg BW)

Adjustment Factors (AF)				Justification for adjustment factor
R	1	2	3	R = 1 is AF for same order and trophic level R = 2 is AF for different order and same trophic level R = 3 is AF for different order and trophic level
I	2	2	2	15 males and 15 females tested, no juveniles
Q ₁	1	1	1	Endpoint ecologically relevant (mortality, BW, and blood chemistry)
Q ₂	2	2	2	Subchronic duration
Q ₃	2	2	2	LOAEL
U	1	1	1	High quality study, but no NOAEL dose was found, all doses were toxic
Total AF	8	16	24	$R * I * Q_1 * Q_2 * Q_3 * U = \text{Total AF}$
QCE (mg/kg-day)	207	207	207	QCE = quantified critical endpoint
TRV	25.9	12.9	8.63	Toxicity Reference Value = QCE/Total AF

R Value	TRV (mg/kg-day)	Justification	Appropriate Functional Group
1	25.9	Test organism is in the same order and trophic level as the functional group members	AV142, AV143
2	12.9	Test organism is in a different order and same trophic level from the functional group members	AV121, AV122, AV132
3	8.63	Test organism is in a different order and trophic level from the functional group members	AV210, AV210A, AV221, AV222, AV222A, AV232, AV233, AV241, AV242, AV310, AV322, AV333, AV342, AV422, AV432, AV433, AV442

*Ingestion rate specified in article, converted to ounces/10 days to kg/day

**BW estimated by interpolation of values given in the Wildlife Exposures Handbook and an average of 77% weight loss(given in article). $682 * 0.77 = 525 \text{ g}$

COPC: Zinc (zinc oxide) CAS 7440-66-6

Test Organisms: Rat (Omnivore, Order-Rodentia)

Exposure Medium: Diet

Test Endpoint: NOAEL

Reference: Schlicker, S.A. and D.H. Cox, 1968, "Maternal dietary zinc and development and zinc, iron and copper content of the rat fetus," *Journal of Nutrition*, 95:287-294.
ATSDR, Agency for Toxic Substance Disease Registry, 1988, Draft: Toxicological Profile for Zinc, December.

QCE: 170 mg/kg-day

Adjustment Factors (AF)				Justification for adjustment factor
R	1	2	3	R = 1 is AF for same order and trophic level R = 2 is AF for different order and same trophic level R = 3 is AF for different order and trophic level
I	2	2	2	Smaller number (60) of females tested.
Q ₁	1	1	1	Ecologically relevant endpoint (developmental effects)
Q ₂	1	1	1	Chronic duration (36 days)
Q ₃	1	1	1	NOAEL
U	2	2	2	Good design, reproductive endpoints and sensitive life stage examined, only 2 doses tested.
Total AF	4	8	12	$R * I * Q_1 * Q_2 * Q_3 * U = \text{Total AF}$
QCE (mg/kg-day)	170	170	170	QCE = quantified critical endpoint
TRV	43	21	14	Toxicity Reference Value = QCE/Total AF

R Value	TRV (mg/kg-day)	Justification	Appropriate Functional Group
1	43	Test organism is in the same order and trophic level as the functional group members	none
2	21	Test organism is in a different order and same trophic level from the functional group members	M422, M422A
3	14	Test organism is in a different order and trophic level from the functional group members	M121, M122, M122A, M132, M210, M210A, M222, M322

COPC: Cobalt (cobalt chloride) CAS 7440-48-4

Test Organisms: Chicken (Omnivore, Order-Galliformes)

Exposure Medium: Diet

Test Endpoint: LOAEL Increased mortality associated with *S. gallinarium* infection

Reference: Hill, C.H., 1979, "The effect of dietary protein levels on mineral toxicity in chicks," Journal of Nutrition, 109:501-507.

QCE: 10.2 mg/kg-day 100 ppm in diet converted to dose using an ingestion rate* of 0.02 kg/day and estimated body weight of 0.2kg from study.

Adjustment Factors (AF)				Justification for adjustment factor
R	1	2	3	R = 1 is AF for same order and trophic level R = 2 is AF for different order and same trophic level R = 3 is AF for different order and trophic level
I	2	2	2	Adequate numbers of animals, but variability not addressed.
Q ₁	1	1	1	Endpoint ecologically relevant
Q ₂	2	2	2	Subchronic duration
Q ₃	2	2	2	LOAEL
U	2	2	2	No reproductive endpoints examined, but sensitive life stage evaluated
Total AF	16	32	48	$R * I * Q_1 * Q_2 * Q_3 * U = \text{Total AF}$
QCE (mg/kg-day)	10.2	10.2	10.2	QCE = quantified critical endpoint
TRV	0.638	0.319	0.213	Toxicity Reference Value = QCE/Total AF

R Value	TRV (mg/kg-day)	Justification	Appropriate Functional Group
1	0.638	Test organism is in the same order and trophic level as the functional group members	none
2	0.319	Test organism is in a different order and same trophic level from the functional group members	AV422, AV432, AV433, AV442
3	0.213	Test organism is in a different order and trophic level from the functional group members	AV121, AV122, AV132, AV142, AV143, AV210, AV210A, AV221, AV222, AV222A, AV232, AV233, AV241, AV242, AV310, AV322, AV333, AV342

* Estimated as $0.0582 \text{ Wt}^{0.651}$ (kg) as cited in EPA, 1993. Wildlife Exposure Factors Handbook.

COPC: Cobalt CAS 7440-48-4

Test Organisms: Dog (Omnivore, Order-Carnivora)

Exposure Medium: Diet

Test Endpoint: NOAEL

Reference: Brewer, B., 1940, "A statistical study of cobalt polycythemia in the dog," Am. J. Physiol. 128:345-348.
Agency for Toxic Substance Disease Registry (ATSDR), 1990, Draft: Toxicological Profile for Cobalt, October.

QCE: 5.0 mg/kg-day Specified

Adjustment Factors (AF)				Justification for adjustment factor
R	1	2	3	R = 1 is AF for same order and trophic level R = 2 is AF for different order and same trophic level R = 3 is AF for different order and trophic level
I	2	2	2	Only females tested, 7 total dogs.
Q ₁	0.1	0.1	0.1	Endpoint of unknown ecological significance
Q ₂	2	2	2	Subchronic duration (4 weeks)
Q ₃	1	1	1	NOAEL
U	3	3	3	Older study, reasonable design, no reproductive endpoints or sensitive life stage examined.
Total AF	1.2	2.4	3.6	$R * I * Q_1 * Q_2 * Q_3 * U = \text{Total AF}$
QCE (mg/kg-day)	5	5	5	QCE = quantified critical endpoint
TRV	4.2	2.1	1.4	Toxicity Reference Value = QCE/Total AF

R Value	TRV (mg/kg-day)	Justification	Appropriate Functional Group
1	4.2	Test organism is in the same order and trophic level as the functional group members	M422A
2	2.1	Test organism is in a different order and same trophic level from the functional group members	M422
3	1.4	Test organism is in a different order and trophic level from the functional group members	M121, M122, M122A, M123, M210, M210A, M222, M322

COPC: Cobalt CAS 7440-48-4

Test Organisms: Rat (Omnivore, Order-Rodentia)

Exposure Medium: Diet

Test Endpoint: NOAEL

Reference: Nation, J.R., Bourgeois, A.E., Clark, D.E. et al., 1983, "The effects of chronic cobalt exposure on behavior and metallothionein levels in the adult rat," Neurobehav. Toxicol. and Teratology, 5:9-15.

Agency for Toxic Substance Disease Registry (ATSDR), 1990, Draft: Toxicological Profile for Cobalt, October.

QCE: 5 mg/kg-day Specified

Adjustment Factors (AF)				Justification for adjustment factor
R	1	2	3	R = 1 is AF for same order and trophic level R = 2 is AF for different order and same trophic level R = 3 is AF for different order and trophic level
I	3	3	3	Small number of male rats tested (18)
Q ₁	1	1	1	Endpoint of relevant ecological significance
Q ₂	2	2	2	Subchronic duration
Q ₃	1	1	1	NOAEL endpoint
U	2	2	2	Reasonable study, but sensitive life stage not examined
Total AF	12	24	36	$R * I * Q_1 * Q_2 * Q_3 * U = \text{Total AF}$
QCE (mg/kg-day)	5	5	5	QCE = quantified critical endpoint
TRV	0.42	0.21	0.14	Toxicity Reference Value = QCE/Total AF

R Value	TRV (mg/kg-day)	Justification	Appropriate Functional Group
1	0.42	Test organism is in the same order and trophic level as the functional group members	none
2	0.21	Test organism is in a different order and same trophic level from the functional group members	M422, M422A
3	0.14	Test organism is in a different order and trophic level from the functional group members	M121, M122, M122A, M132, M210, M210A, M222, M322

COPC:**Vanadium (Vanadyl sulfate) CAS 27774-13-6****Test Organisms:**

Chicken (Omnivore, Order-Galliformes)

Exposure Medium:

Diet

Test Endpoint:

NOAEL

Reference:Kubena, L.F. and T.D. Phillips, 1982, "Toxicity of vanadium in female leghorn chickens," Poultry Science, 62:47-50.**QCE:**

1.7 mg/kg-day

25 ppm in diet converted to dose using an estimated 0.1 kg/day ingestion rate and 1.5 kg BW as indicated in study

Adjustment Factors (AF)				Justification for adjustment factor
R	1	2	3	R = 1 is AF for same order and trophic level R = 2 is AF for different order and same trophic level R = 3 is AF for different order and trophic level
I	1	1	1	Subchronic study with adequate numbers of animals
Q ₁	1	1	1	Endpoint ecologically relevant (growth and egg production)
Q ₂	2	2	2	Subchronic duration
Q ₃	1	1	1	NOAEL
U	2	2	2	Multiple doses evaluated, good statistical analysis of data, but only weight and egg production were evaluated.
Total AF	4	8	12	$R * I * Q_1 * Q_2 * Q_3 * U = \text{Total AF}$
QCE (mg/kg-day)	1.7	1.7	1.7	QCE = quantified critical endpoint
TRV	0.43	0.21	0.14	Toxicity Reference Value = QCE/Total AF

R Value	TRV (mg/kg-day)	Justification	Appropriate Functional Group
1	0.43	Test organism is in the same order and trophic level as the functional group members	none
2	0.21	Test organism is in a different order and same trophic level from the functional group members	AV422, AV432, AV433, AV442
3	0.14	Test organism is in a different order and trophic level from the functional group members	AV121, AV122, AV132, AV142, AV143, AV210, AV210A, AV221, AV222, AV222A, AV232, AV233, AV241, AV242, AV310, AV322, AV333, AV342

**FI=0.0582(BW)^{0.651} cited in EPA Wildlife Exposures Handbook

COPC:**Vanadium (Vanadyl sulfate) CAS 27774-13-6****Test Organisms:**

Mallard (Herbivore, Order-Anseriformes)

Exposure Medium:

Diet

Test Endpoint:

NOAEL

Reference:White, D.H. and M.P. Dieter, 1978, 'Effects of dietary vanadium in mallard ducks. Journal of Toxicology and Environmental Health.**QCE:**

1.0 mg/kg-day

10 ppm in diet converted to dose using 0.121 kg/day ingestion rate and 1.17 kg BW as indicated in study.

Adjustment Factors (AF)				Justification for adjustment factor
R	1	2	3	R = 1 is AF for same order and trophic level R = 2 is AF for different order and same trophic level R = 3 is AF for different order and trophic level
I	2	2	2	Subchronic study with adequate numbers of animals
Q ₁	0.5	0.5	0.5	Ecological relevance of endpoint questionable (altered lipid metabolism)
Q ₂	2	2	2	Subchronic duration
Q ₃	1	1	1	NOAEL
U	2	2	2	No reproductive endpoint evaluated, multiple doses evaluated
Total AF	4	8	12	$R * I * Q_1 * Q_2 * Q_3 * U = \text{Total AF}$
QCE (mg/kg-day)	1.0	1.0	1.0	QCE = quantified critical endpoint
TRV	0.25	0.13	0.08	Toxicity Reference Value = QCE/Total AF

R Value	TRV (mg/kg-day)	Justification	Appropriate Functional Group
1	0.25	Test organism is in the same order and trophic level as the functional group members	AV142, AV143
2	0.13	Test organism is in a different order and same trophic level from the functional group members	AV121, AV122, AV132
3	0.08	Test organism is in a different order and trophic level from the functional group members	AV210, AV210A, AV221, AV222, AV222A, AV232, AV233, AV241, AV242, AV310, AV322, AV333, AV342, AV422, AV432, AV433, AV442

COPC:**Vanadium (Vanadyl sulfate) CAS 27774-13-6****Test Organisms:**

Mouse (Omnivore, Order-Rodentia)

Exposure Medium:

Diet

Test Endpoint:

NOAEL

Reference:Schroeder, H.A. and J.J. Balassa, 1967, "Arsenic, germanium, tin and vanadium in mice: Effects on growth, survival and tissue levels," *Journal of Nutrition*, 92:245-252.

ATSDR. Agency for Toxic Substance Disease Registry. 1990. Draft: Toxicological Profile for Vanadium. October, 1990.

QCE:

4.1 mg/kg-day

Adjustment Factors (AF)				Justification for adjustment factor
R	1	2	3	R = 1 is AF for same order and trophic level R = 2 is AF for different order and same trophic level R = 3 is AF for different order and trophic level
I	1	1	1	108 males and females tested
Q ₁	1	1	1	Ecologically relevant endpoint (body weight gain)
Q ₂	1	1	1	Chronic duration
Q ₃	1	1	1	NOAEL
U	3	3	3	Older study, reproductive endpoints and sensitive life stage not examined,. Only one dose was tested, no LOAEL found.
Total AF	3	6	9	$R * I * Q_1 * Q_2 * Q_3 * U = \text{Total AF}$
QCE (mg/kg-day)	4.1	4.1	4.1	QCE = quantified critical endpoint
TRV	1.37	0.68	0.46	Toxicity Reference Value = QCE/Total AF

R Value	TRV (mg/kg-day)	Justification	Appropriate Functional Group
1	1.37	Test organism is in the same order and trophic level as the functional group members	none
2	0.68	Test organism is in a different order and same trophic level from the functional group members	M422, M422A
3	0.46	Test organism is in a different order and trophic level from the functional group members	M121, M122, M122A, M132, M210, M210A, M222, M322

COPC: Vanadium (Ammonium metavanadate) CAS 7803-55-6

Test Organisms: Bovine (calves)

Exposure Medium: Gelatin capsule

Test Endpoint: NOAEL Clinical symptoms

Reference: Platonow, N. and H.K. Abbey, 1968, 'Toxicity of Vanadium in Calves'. *Vet. Record*, 82:292.

QCE: 7.5 mg/kg-day

Adjustment Factors (AF)				Justification for adjustment factor
R	1	2	3	R = 1 is AF for same order and trophic level R = 2 is AF for different order and same trophic level R = 3 is AF for different order and trophic level
I	2	2	2	10 young males
Q ₁	1	1	1	Ecologically relevant endpoint.
Q ₂	2	2	2	Subchronic duration
Q ₃	1	1	1	NOAEL
U	2	2	2	Older study, reproductive and sensitive endpoints not evaluated.
Total AF	8	16	24	$R * I * Q_1 * Q_2 * Q_3 * U = \text{Total AF}$
QCE (mg/kg-day)	7.5	7.5	7.5	QCE = quantified critical endpoint
TRV	0.94	0.47	0.31	Toxicity Reference Value = QCE/Total AF

R Value	TRV (mg/kg-day)	Justification	Appropriate Functional Group
1	0.94	Test organism is in the same order and trophic level as the functional group members	none
2	0.47	Test organism is in a different order and same trophic level from the functional group members	M121, M122, M122A, M123, M132
3	0.31	Test organism is in a different order and trophic level from the functional group members	M210, M210A, M222, M322, M422, M422A

COPC: Benzene CAS 71-43-2

Test Organisms: Mouse (Omnivore, Order-Rodentia)

Exposure Medium: Oral (gavage)

Test Endpoint: LOAEL

Reference: Nawrot, P.S. and R.E. Staples. 1979. "Embryofetal toxicity and teratogenicity of benzene and toluene in the mouse." *Teratology*. 19: 41A.

QCE: 263.6 mg/kg-day [0.3mL Benzene/kg BW * 0.8787 g Benzene/mL Benzene * 1000mg/g] = 263.6 mg/kg-day

Adjustment Factors (AF)				Justification for adjustment factor
R	1	2	3	R = 1 is AF for same order and trophic level R = 2 is AF for different order and same trophic level R = 3 is AF for different order and trophic level
I	2	2	2	days 6-12 of gestation
Q ₁	1	1	1	Ecologically relevant endpoint (reproduction).
Q ₂	3	3	3	Short duration
Q ₃	2	2	2	LOAEL
U	2	2	2	Three dose levels, exposure at highest two doses (0.5 and 1.0 mL/kg/d significantly increased maternal mortality and embryonic resorption. Fetal weights were significantly reduced by all three dose levels.
Total AF	24	48	72	$R * I * Q_1 * Q_2 * Q_3 * U = \text{Total AF}$
QCE (mg/kg-day)	263.6	263.6	263.6	QCE = quantified critical endpoint
TRV	10.98	5.49	3.66	Toxicity Reference Value = QCE/Total AF

R Value	TRV (mg/kg-day)	Justification	Appropriate Functional Group
1	10.98	Test organism is in the same order and trophic level as the functional group members	none
2	5.49	Test organism is in a different order and same trophic level from the functional group members	M422, M422A
3	3.66	Test organism is in a different order and trophic level from the functional group members	M121, M122, M122A, M132, M210, M210A, M222, M322

COPC:**Benzene CAS 71-43-2****Test Organisms:**

Mouse and Rat (Omnivore, Order-Rodentia)

Exposure Medium:

Oral (gavage)

Test Endpoint:

FEL

Reference:National Toxicology Program (NTP), 1986, *Toxicology and Carcinogenesis Studies of Benzene in F344/N Rats and B6C3F Mice (Gavage Studies)*, NTP Technical Report Series No. 289, NIH Publication No. 86-2545.**QCE:**

25 mg/kg-day

Adjustment Factors (AF)				Justification for adjustment factor
R	1	2	3	R = 1 is AF for same order and trophic level R = 2 is AF for different order and same trophic level R = 3 is AF for different order and trophic level
I	2	2	2	No juveniles of either species tested.
Q ₁	1	1	1	Ecologically relevant endpoint
Q ₂	1	1	1	Long-term (103-week) study
Q ₃	3	3	3	FEL
U	2	2	2	Numerous other studies exist to support these findings. Adequate number of animals from both sexes of the two species tested.
Total AF	12	24	36	$R * I * Q_1 * Q_2 * Q_3 * U = \text{Total AF}$
QCE (mg/kg-day)	25	25	25	QCE = quantified critical endpoint
TRV	2.1	1.0	0.69	Toxicity Reference Value = QCE/Total AF

R Value	TRV (mg/kg-day)	Justification	Appropriate Functional Group
1	2.1	Test organism is in the same order and trophic level as the functional group members	none
2	1.0	Test organism is in a different order and same trophic level from the functional group members	M422, M422A
3	0.69	Test organism is in a different order and trophic level from the functional group members	M121, M122, M122A, M132, M210, M210A, M222, M322

